



This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

### Usage guidelines

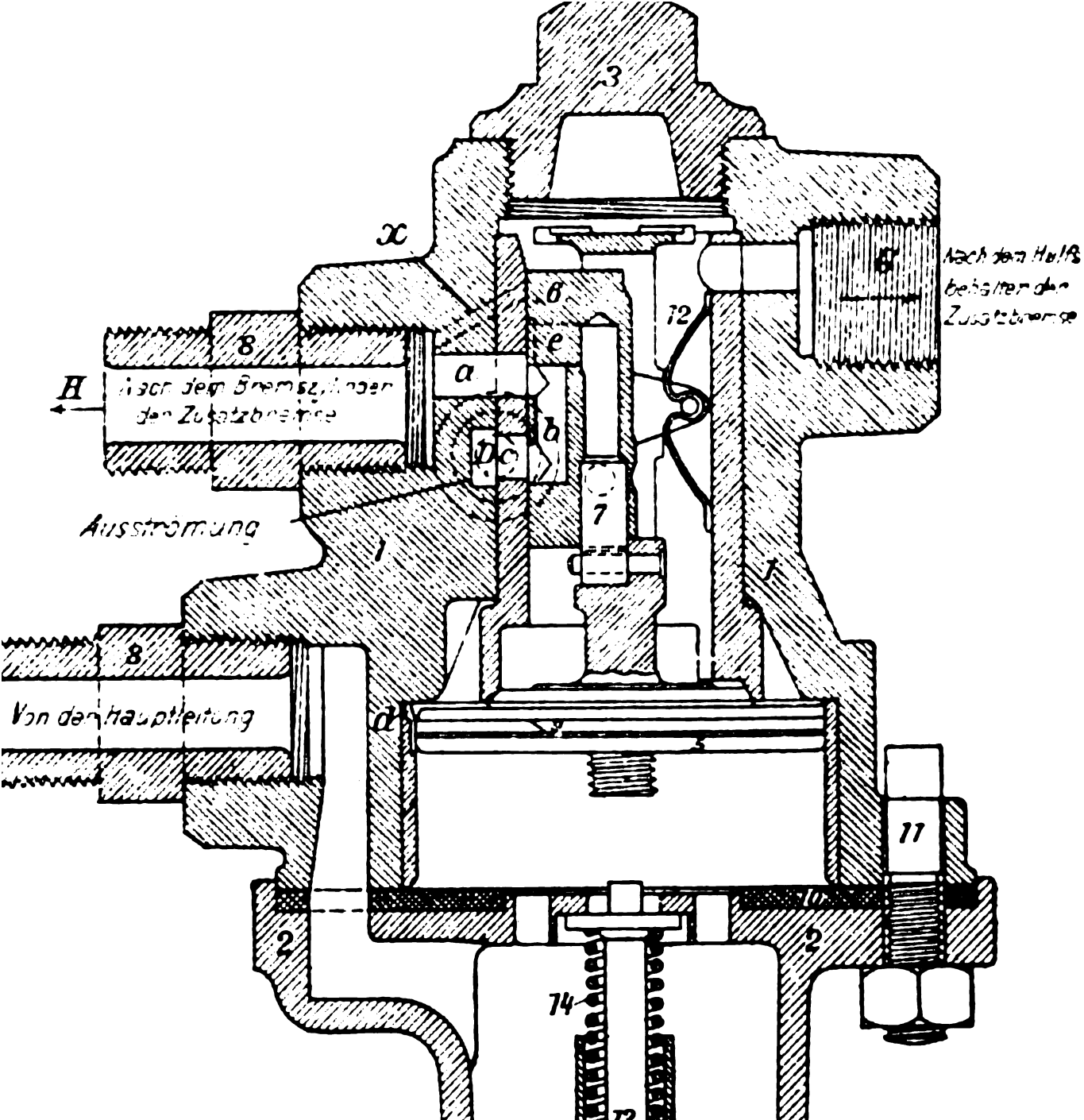
Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

- + *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
- + *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
- + *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
- + *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

### About Google Book Search

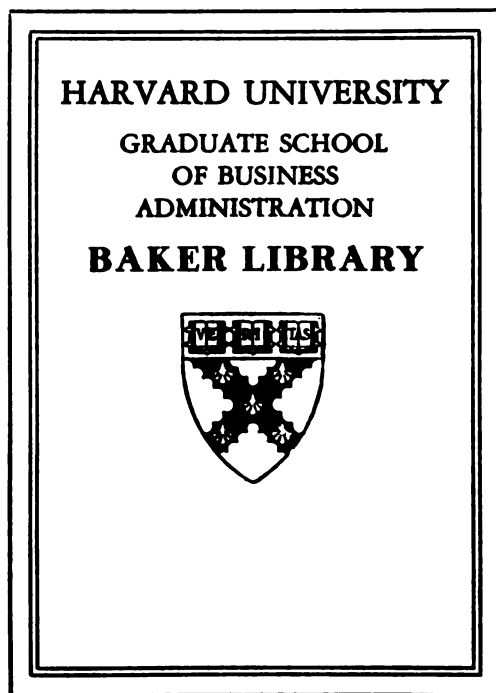
Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at <http://books.google.com/>



# Bulletin of the International Railway Congress Association

International Railway Congress Association

F-20053











International railway congress association  
...Bulletin ...

Index for v.20, Jan.-Dec.1906

Bound in v.20<sup>1</sup> in June 1906 issue

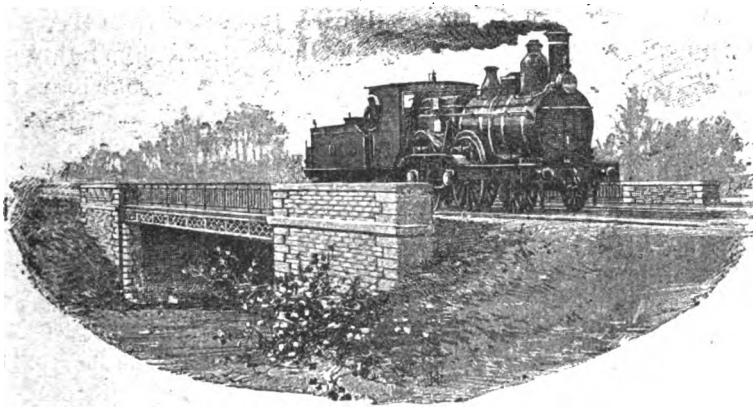


YEARLY SUBSCRIPTION (Jan. to Dec. only) PAYABLE IN ADVANCE, £1.4s. = \$6.

Vol. XX. — No. 7. — July, 1906.

11<sup>th</sup> Year of the English Edition.

**BULLETIN**  
OF THE  
**INTERNATIONAL RAILWAY CONGRESS**  
ASSOCIATION  
(ENGLISH EDITION)  
[ 385. (05) ]



Editorial communications should be addressed  
to the Permanent Commission (Executive Committee) of the International Railway Congress Association  
rue de Louvain, 11, Brussels.

**BRUSSELS**  
**PUBLISHED BY P. WEISSENBRUCH, PRINTER TO THE KING**  
49, rue du Poinçon.

**LONDON**  
**P. S. KING AND SON, PARLIAMENTARY AND GENERAL BOOKSELLERS**  
2 and 4, Great Smith Street, Westminster, S. W.

**The Permanent Commission of the Association is not responsible for the opinions expressed  
in the articles published in the BULLETIN.**

# NOTICE

---

All editorial communications intended for the *Bulletin* should be addressed to Mr. Louis Weissenbruch, General Secretary of the Permanent Committee, International Railway Congress Association, 11, rue de Louvain, Brussels. The *Bulletin*, which is published in monthly numbers forming an annual volume of more than 800 pages, contains the whole of the proceedings and publications of the Congress of every kind. Copies are sent gratuitously to all the Companies, members of the Congress, at the rate of one copy for each delegate which the Company is entitled to send to a Congress meeting with one extra copy for the Company's own library.

The *Bulletin* can be supplied at the rate of 25 francs = £1 = \$5 per annum, not including postage; or 30 francs = £1.4s. = \$6 including postage to subscribers who send their subscriptions in advance by cheque or postal order direct to the publisher, Paul Weissenbruch, 49, rue du Poinçon, Brussels.

---

*N. B.* — The annual subscription, which must be paid in advance and dates from the January of the year for which the subscription is sent, does not vary even when the number of pages in the year's issue greatly exceeds 800 pages (the 1900 volume of the English edition consisted of 3988 pages). But the price of each monthly number, if bought separately, is fixed according to the number of pages it contains as follows:

2s. (50 cents) per 72 pages not including postage.

It is therefore evident that there is a great gain in subscribing for the whole year.

---

The whole years 1896, 1897, 1898, 1899, 1900, 1901, 1902, 1903, 1904 and 1905 of the English edition of the *Bulletin* containing 1,370, 1,824, 1,634, 1,695, 3,988, 2,734, 1,129, 1,353, 2,066 and 2,626 pages, may be obtained each at 35 francs = £1.8s. = \$7, including postage.

---

Previous volumes of the *Bulletin*, published in French only, contained 1,574, 1,196, 2,194, 1,576, 749, 4,114, 1,124, 1,118, 3,812 and 1,632 pages, illustrated with numerous plates and diagrams, for the years 1887 to 1896 respectively may be obtained at the same price.

---

PAPERS PUBLISHED FOR THE FIFTH SESSION : A detailed list of the papers, notes, and technical information, prepared for the London meeting, is given on the third page of the cover.

Copies may be had on application to the publisher, 49, rue du Poinçon, enclosing remittance of the price as given in the list opposite each paper on the third page of the cover. (*N. B.* 1 franc = 10d. = 20 cents.)

**BULLETIN**  
OF THE  
**INTERNATIONAL RAILWAY CONGRESS**  
**ASSOCIATION**  
(ENGLISH EDITION)



[ 686 .257 ]

**WIRE ROPES USED IN TRANSMISSIONS FOR OPERATING SWITCHES AND SIGNALS :**

TRIALS MADE IN ORDER TO DETERMINE THE BEST SPECIFICATION FOR SUCH ROPES,

By Mr. GADOW,  
RAILWAY ENGINEER, DORTMUND.



Figs. 1 to 4, pp. 1043 to 1053.

(*Organ für die Fortschritte des Eisenbahnwesens*).



Wire ropes are an important item in the transmissions for operating switches and signals. The direction in which they transmit a pull can be altered by running them over sheaves, and so they can conveniently be used for operating switches and signals and interlocking gear. The good working of the whole arrangement depends chiefly on them.

If the fracture of such transmissions is to be detected, and the possibility of setting switches and signals in dangerous positions is to be avoided, it is necessary for the signal levers to be fitted with interlocking gear, making any dangerous combination impossible if any transmission has broken down. Now experience has shown that any such failure is nearly always due, certainly in about 90 per cent of the cases, to the fracture of the wire ropes.

In the case of wire transmissions, galvanized steel wire having a diameter of 4 or 5 millimetres (0.157 or 0.197 inch) is used; such wire has an ultimate tensile strength of from 1,200 to 1,900 kilograms (2,645 to 4,189 lb.) and only works in tension. Even

WA.9  
I 61  
v. 202  
July-Dec.  
1906

if a signalman is violent in operating a lever, there is no danger of breaking the wire, although it has already been exposed a considerable time to the action of the weather.

The conditions are far less favourable in the case of wire ropes. They also it is true may be assumed to work only in tension, if we consider them as a whole; but the wires of which they are composed are subjected to compressive and bending stresses.

For these reasons, stringent conditions are generally inserted in the specifications for wire ropes which are to be used for transmissions. But up to the present, experimental data, as to the particular properties such wire ropes should possess, have been entirely lacking, and the specifications usual up to the present, were only in part based on any actual knowledge.

In accordance with an order issued by the Prussian Minister of Public Works, the Signalling Board proceeded to carry out an extended series of trials in order to determine the best specification for such wire rope for use on the Prussian State Railway; we will give an account of them here.

It was decided that in order to obtain really reliable data, it was necessary, in the course of the trials, to subject the wire ropes to the same stresses as they would be subjected to in actual use. Consequently the trials have not been limited to determining the strength and flexibility of the ropes, the arrangement of the wires in the strands and of the strands in the ropes, the thickness of the layer of zinc; the ropes while under a tensile stress of 100 kilograms (220 lb.) were also subjected to alternate bending, by being passed over sheaves having diameters of 230 and 140 millimetres ( $9 \frac{1}{16}$  and  $5 \frac{1}{2}$  inches) forwards and backwards, until they broke. Sheaves of these diameters are those most often used in actual working.

The number of double bendings which the different wire ropes stood, forms a very definite criterium for determining the quality of the ropes. The testing machine which was used is shown in figures 2 and 3.

The two ends of the rope to be tested are secured to the two bolts S of the cross-head K. The rope passes over a sheave R (in a stationary block) having a diameter of 690 or 420 millimetres (2 ft.  $3 \frac{5}{32}$  in. or 1 ft.  $4 \frac{9}{16}$  in.), and there are three sheaves r having a diameter of 230 or 140 millimetres ( $9 \frac{1}{32}$  or  $5 \frac{1}{2}$  inches); these three sheaves form part of the block F which can move in a vertical plane. This block is weighted so that the rope is subjected to a tension of 100 kilograms (220 lb.). The block can go down lower, so as to allow for any stretch of the rope; but it cannot go up or else variations would be produced by the resulting difference of tension between the tight and the slack parts of the rope, and jerks might occur which would subject the rope to stresses which could not be measured. For the same reason, the spring stops B are provided to take up the momentum of the upper sheave R. The cross-head K is connected by a rod P to a crank which is operated by a belt-driven pulley. The cross-head makes 40 complete strokes (up and down) per minute, each of which corresponds to a double bending (to and fro) of the rope; the number of strokes is recorded automatically by a counter Z operated by the upper sheave R. This speed of 40 strokes per minute was adopted because the resulting speed of the rope corresponded to that occurring in actual practice; and besides it was feared that vibrations would be produced if a higher speed were adopted. At the moment the rope breaks, the sheave R stops, and consequently the counter also stops.

During this operation, the sections *ab* and *cd* on the sheaves *r* of the block F are

HCL  
5

subjected to S-shaped bending, and it is always in one of these two sections that the rope breaks.

Another stationary sheave  $r_1$  is placed between the upper sheave R and the sheaves  $r$  of the block F; it is provided in order to make it possible to use the apparatus for ropes which are only to be subjected to simple bending.

The ultimate tensile strength of the steel used for the ropes was not determined in the ordinary testing machine, because this would not give sufficiently accurate readings for such fine wires; these were slowly weighted direct by means of shot until they broke. Ten wires of each rope were broken, and the mean was taken as the ultimate tensile strength of the wire. The cross-section of the wire was measured by means of a micrometer reading to 0.005 millimetre (0.000197 inch); before measuring, the layer of zinc (which did not contribute to the tenacity) was carefully removed by means of a solution of hydrochloric acid, and then the wires were washed in pure water and dried.

Besides the ultimate tensile strength, the resistance of the wires to bending was also determined by fixing them in a vice with two steel jaws, the upper edges of which were rounded to a radius of 2.5 millimetres (0.09843 inch) (fig. 1), and then bending them to and fro, through an angle of 180°, till they broke. The initial half bend through 90° was not taken into account.

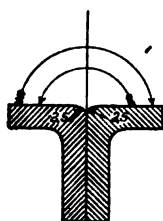


Fig. 1.

The thickness of the layer of zinc coating the ropes tested was determined in two ways. In the first place the diameter of the wire was measured by means of the micrometer, then the zinc was dissolved by dilute hydrochloric acid, the wire washed in pure water, dried, and measured again. Secondly the following process was used: the wire was immersed (each time for a minute) in a solution of one part of copper sulphate in five parts of water, then washed with pure water and dried by wiping with a piece of linen. These immersions were repeated until a continuous red layer of copper was formed on the wire, showing that all the zinc had been dissolved.

In these tests also, as in the tensile and bending tests, ten tests were made in the case of each rope and the mean value taken as the true value. It was found that a layer of zinc 0.02 millimetre (0.000787 inch) thick would require three to four immersions in the copper sulphate solution; the wires only showed a continuous red layer after four immersions. Two to three immersions correspond to a thickness of zinc of 0.01 to 0.015 millimetre (0.000394 to 0.000591 inch), and a layer of zinc 0.005 millimetre (0.000197 inch) thick disappeared completely during the first immersion.

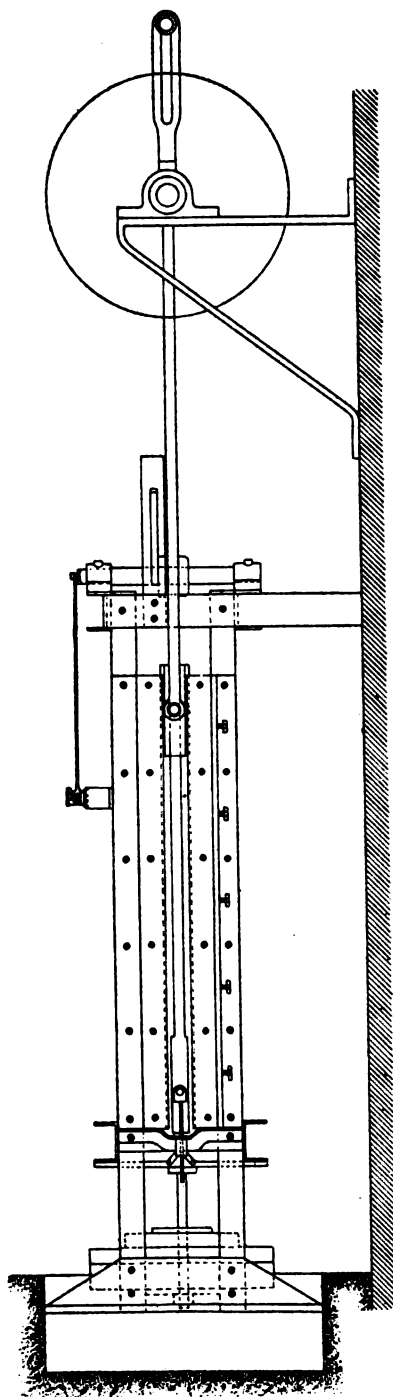


Fig. 2.

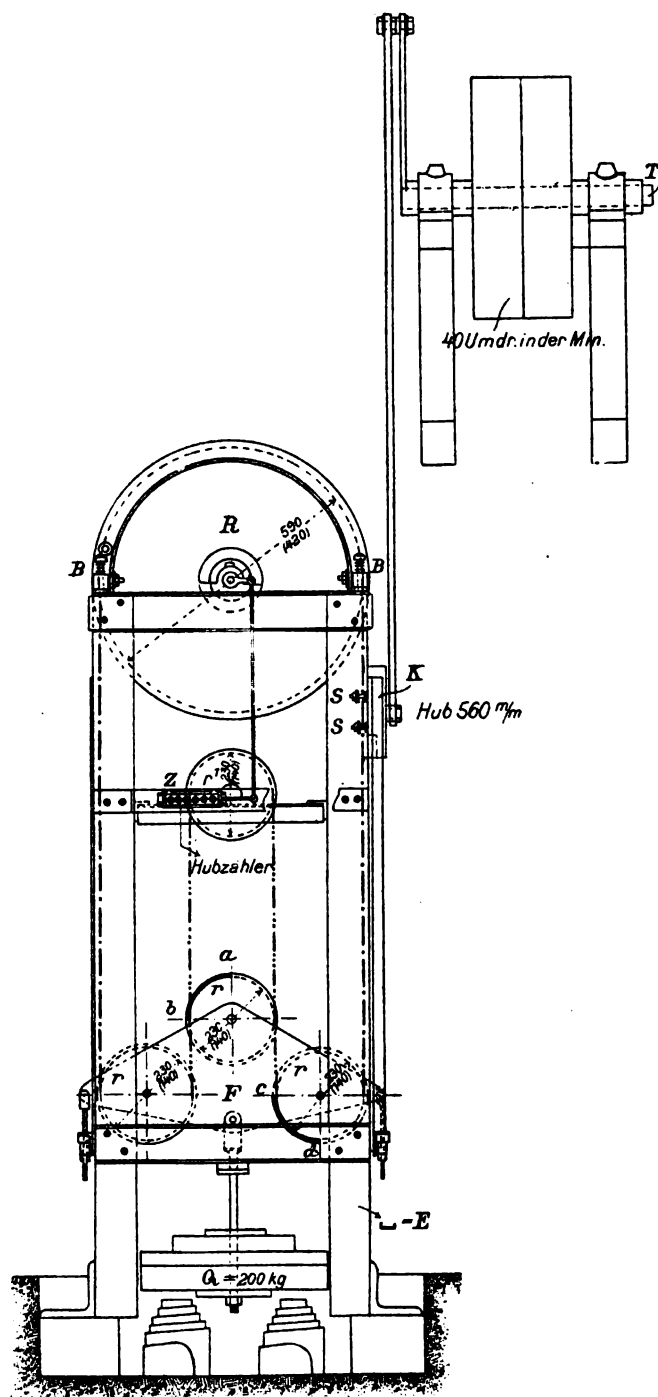


Fig. 3.

Explanation of German terms : 40 Umdr. in der Min. = 40 revolutions per minute. — Hub 560 m.m = Stroke, 560 millimetres (1 ft. 10  $\frac{1}{32}$  in.)  
Hubzähler = Counter recording number of strokes.

**TABLE 1a. — Ropes 7 and 6 millimetres (0.276 and 0.236 inch) in diameter.**

Index number.	Number of trials from which the average was determined.		Composition of rope.		Pitch ratio of strand of rope.		Diameter of wire in millimetres (in inches).	Ultimate tensile strength of wire, in kilograms per square millimetre (in lb. per square inch).	Number of bendings before fracture.	Thickness of sheath coating, in millimetres (in inches).	Diameter, in millimetres (in inches).		Material.	State.	Length of stroke, in millimetres (in inches).	Stress, during trial, on whole rope, in kilograms (in lb.).	Fracture of first wire.	Fracture after the following number of double bendings.
	1	2	3	4	5	6												
1	6	7	7 × 7	18	9	0.7	115	30	0.01	0.00394	3.8	0.1481	Hemp.	Soaked in tar oil.	230	100	6.1	8,057
2 to 6	5	6	6 × 19	13	7	0.4	138	44	0.02	0.00787	3.5	0.13780	Ditto.	Ditto.	230	100	7	6,354
7 to 10	4	6	6 × 19	10	10	0.4	146	39	0.015	0.00591	3	0.11811	Ditto.	Ditto.	230	100	7	6,920
11 to 10	6	6	8 × 12	13	7	0.4	136	44	0.02	0.00787	4	0.15748	Ditto.	Ditto.	230	100	8-1	7,819
17	1	6	8 × 12	18	9	0.4	119	39	0.005	0.00197	3.5	0.13780	Ditto.	Ditto.	230	100	8-3	8,045
18 to 20	3	6	8 × 12	14	7	0.4	149	48	0.01	0.00394	4	0.15748	Ditto.	Ditto.	230	100	8-3	9,758
21 to 24	4	6	6 × 12	13.5	10	0.5	144	40	0.015	0.00591	3	0.11811	Ditto.	Ditto.	230	100	7-7	10,573
25 to 30	6	6	8 × 7	13	6	0.55	133	34	0.02	0.00787	4	0.15748	Ditto.	Ditto.	230	100	7-5	10,594
31 to 35	5	6	7 × 7	13	8.6	0.6	108	35	0.01	0.00394	3.5	0.13780	Ditto.	Unsoaked.	230	100	8-2	7,908
						(0.02362)	(153,606)								(220 lb.)	(11,663)		

**TABLE 1b. — Ropes 6 millimetres (0.236 inch) in diameter.**

1 to 6	6	6	6 × 19	13	7	0.4	138	44	0.02	0.00787	3.5	0.13780	Hemp.	Soaked in tar oil.	140	100	7	1,781
7	1	6	6 × 19	16	10	0.4	146	39	0.015	0.00591	3	0.11811	Ditto.	Ditto.	140	100	7	2,397
8 to 9	2	6	8 × 12	13	7	0.4	136	44	0.02	0.00787	4	0.15748	Ditto.	Ditto.	140	100	8-3	2,731
10	1	6	8 × 12	18	9	0.4	119	39	0.005	0.00197	3.5	0.13780	Ditto.	Ditto.	140	100	8-3	2,182
11 to 12	2	6	8 × 12	14	7	0.4	149	48	0.01	0.00394	4	0.15748	Ditto.	Ditto.	140	100	8-3	2,228
13 to 14	2	6	6 × 12	13.5	10	0.5	144	40	0.015	0.00591	3	0.11811	Ditto.	Ditto.	140	100	7-7	3,308
15 to 18	4	6	8 × 7	13	7	0.55	133	34	0.02	0.00787	4	0.15748	Ditto.	Ditto.	140	100	7-5	2,745
19 to 21	3	6	7 × 7	13	8.6	0.6	108	35	0.01	0.00394	3.5	0.13780	Ditto.	Unsoaked.	140	100	7-2	2,419
						(0.02362)	(153,606)								(220 lb.)	(10,240)		

*Note.* — In figure 3, the thick line shows the part of the rope subjected to double bending.

Index number.	Number of trials from which the average was determined.		Composition of rope.		Pitch ratio of strand.		Diameter of wire, in millimetres (in inches).	Ultimate tensile strength of wire, in kilograms (in lb. per square inch).	Number of bends before fracture.	Thickness of zinc coating, in millimetres (in inches).	Diameter, in millimetres (in inches).		Material of core.	State	Diameter of sheave, in millimetres (in inches).		Length, in millimetres (in inches).	Stress, during trial, on whole rope, in kilograms (in lb., sq. inch).		Fracture of first wire	Fracture after the following number of double bendings.

TABLE IIa. — Ropes 5 millimetres (0.197 inch) in diameter.

1 to 6	6	5	6 × 12	13	7	0.4 (0.0157)	144 (204,909)	29	0.02 (0.000787)	3 (0.1181)	Hemp.	Soaked in tar oil.	230 (9 1/8 in.)	500 (1 ft. 10 1/8 in.)	100 (220 lb.)	11.1 (15,787)	5.541	27,418		
7 to 9	3	5	6 × 12	19	9.5	0.4 (0.0157)	138 (196,275)	42	0.015 (0.000391)	3 (0.1181)	Ditto.	Ditto.	230 (9 1/8 in.)	500 (1 ft. 10 1/8 in.)	100 (220 lb.)	11.1 (15,787)	9.283	27,924		
10	1	5	6 × 12	18	9	0.4 (0.0157)	119 (169,252)	39	0.005 (0.000197)	2.5 (0.0843)	Ditto.	Ditto.	230 (9 1/8 in.)	500 (1 ft. 10 1/8 in.)	100 (220 lb.)	11.1 (15,787)	7.062	36,654		
11 to 13	3	5	8 × 7	14	7	0.45 (0.0172)	138 (196,275)	38	0.02 (0.000787)	3.5 (0.1378)	Ditto.	Ditto.	230 (9 1/8 in.)	500 (1 ft. 10 1/8 in.)	100 (220 lb.)	11.1 (15,787)	9.779	28,750		
14 to 16	3	5	8 × 7	13	6.5	0.4 (0.0157)	152 (216,187)	47	0.01 (0.000394)	3 (0.1181)	Ditto.	Ditto.	230 (9 1/8 in.)	500 (1 ft. 10 1/8 in.)	100 (220 lb.)	14.2 (20,196)	14.508	30,156		
17 to 20	4	5	7 × 7	14	7	0.5 (0.0199)	122 (173,318)	48	0.02 (0.000787)	3 (0.1181)	Ditto.	Ditto.	230 (9 1/8 in.)	500 (1 ft. 10 1/8 in.)	100 (220 lb.)	10.3 (14,650)	10.017	35,812		
21 to 26	6	5	7 × 7	15	9	0.5 (0.0199)	107 (152,184)	36	0.01 (0.000394)	3 (0.1181)	Ditto.	Unsoaked.	230 (9 1/8 in.)	500 (1 ft. 10 1/8 in.)	100 (220 lb.)	10.3 (14,650)	8.086	29,929		
27 to 29	3	5	7 × 7	20	10	0.5 (0.0199)	130 (184,897)	36	0.015 (0.000391)	2.8 (0.1024)	Ditto.	Soaked in tar oil.	230 (9 1/8 in.)	500 (1 ft. 10 1/8 in.)	100 (220 lb.)	10.3 (14,650)	12.532	25,013		
30 to 32	3	5	6 × 7	20	10	0.55 (0.02165)	128 (182,152)	42	0.015 (0.000391)	2.8 (0.1024)	Ditto.	Ditto.	230 (9 1/8 in.)	500 (1 ft. 10 1/8 in.)	100 (220 lb.)	10.3 (14,650)	12.778	26,887		
33 to 35	3	5	6 × 7	20	10	0.5 (0.0199)	144 (204,909)	42	0.015 (0.000391)	3 (0.1181)	Ditto.	Ditto.	230 (9 1/8 in.)	500 (1 ft. 10 1/8 in.)	100 (220 lb.)	12 (17,067)	5.851	17,060		
36 to 39	4	5	6 × 7	14	7	0.55 (0.02165)	121 (176,363)	37	0.02 (0.000787)	3 (0.1181)	Ditto.	Ditto.	230 (9 1/8 in.)	500 (1 ft. 10 1/8 in.)	100 (220 lb.)	10 (14,223)	8.409	20,644		

TABLE IIb. — Ropes 5 millimetres (0.197 inch) in diameter.

1 to 2	2	5	6 × 12	13	7	0.4 (0.0157)	144 (204,909)	29	0.02 (0.000787)	3 (0.1181)	Hemp.	Soaked in tar oil.	140 (5 1/2 in.)	500 (1 ft. 10 1/8 in.)	100 (220 lb.)	11.1 (15,787)	1.780	5,190		
3 to 4	2	5	6 × 12	19	9.5	0.4 (0.0157)	138 (196,275)	42	0.015 (0.000391)	3 (0.1181)	Ditto.	Ditto.	140 (5 1/2 in.)	500 (1 ft. 10 1/8 in.)	100 (220 lb.)	11.1 (15,787)	2.718	7,526		
5	1	5	6 × 12	18	9	0.4 (0.0157)	119 (169,252)	39	0.005 (0.000197)	2.5 (0.0843)	Ditto.	Ditto.	140 (5 1/2 in.)	500 (1 ft. 10 1/8 in.)	100 (220 lb.)	11.1 (15,787)	2.282	7,669		
6 to 7	2	5	8 × 7	14	7	0.45 (0.0172)	138 (196,275)	38	0.02 (0.000787)	3.5 (0.1378)	Ditto.	Ditto.	140 (5 1/2 in.)	500 (1 ft. 10 1/8 in.)	100 (220 lb.)	11.1 (15,787)	3.343	5,870		
8 to 9	2	5	8 × 7	13	6.5	0.4 (0.0157)	152 (216,187)	47	0.01 (0.000394)	3 (0.1181)	Ditto.	Ditto.	140 (5 1/2 in.)	500 (1 ft. 10 1/8 in.)	100 (220 lb.)	14.2 (20,196)	2.949	5,359		
10	1	5	7 × 7	14	7	0.5 (0.0199)	122 (173,318)	48	0.02 (0.000787)	3 (0.1181)	Ditto.	Ditto.	140 (5 1/2 in.)	500 (1 ft. 10 1/8 in.)	100 (220 lb.)	10.3 (14,650)	2.875	6,580		
11 to 13	3	5	7 × 7	15	9	0.5 (0.0199)	107 (152,184)	36	0.01 (0.000394)	3 (0.1181)	Ditto.	Unsoaked.	140 (5 1/2 in.)	500 (1 ft. 10 1/8 in.)	100 (220 lb.)	10.3 (14,650)	2.221	4,970		
14 to 16	3	5	7 × 7	20	10	0.5 (0.0199)	130 (184,897)	36	0.015 (0.000391)	2.8 (0.1024)	Ditto.	Soaked in tar oil.	140 (5 1/2 in.)	500 (1 ft. 10 1/8 in.)	100 (220 lb.)	10.3 (14,650)	4.493	7,393		
17 to 19	3	5	6 × 7	20	10	0.55 (0.02165)	128 (182,152)	42	0.015 (0.000391)	2.8 (0.1024)	Ditto.	Ditto.	140 (5 1/2 in.)	500 (1 ft. 10 1/8 in.)	100 (220 lb.)	10 (14,223)	3.753	6,396		
20 to 22	3	5	6 × 7	20	10	0.5 (0.0199)	144 (204,909)	42	0.015 (0.000391)	3 (0.1181)	Ditto.	Ditto.	140 (5 1/2 in.)	500 (1 ft. 10 1/8 in.)	100 (220 lb.)	12 (17,067)	2.082	3,330		
23 to 27	3	5	6 × 7	14	7	0.55 (0.02165)	124 (176,363)	37	0.02 (0.000787)	3 (0.1181)	Ditto.	Ditto.	140 (5 1/2 in.)	500 (1 ft. 10 1/8 in.)	100 (220 lb.)	10 (14,223)	2.495	4,116		

**TABLE IIIa. — Ropes 4, 3.5 and 3 millimetres (0.157, 0.138 and 0.118 inch) in diameter.**

Index number	Number of trials from which the average was determined		Composition of rope.		Pitch ratio of strand.		Diameter of wire in millimetres	Ultimate tensile strength of wire, in kilograms per square inch	Number of bendings before fracture.	Thickness of zinc coating in millimetres	Diameter in millimetres	Material of core.	State.	Diameter of sheave, in millimetres (in inches).		Length of stroke, in millimetres (in inches).	Stress, during trial, on whole rope, in kilograms (in lb.).		Fracture of first wire.	Fracture after following number of double bendings.
	4	5	7 × 7	18	9	11	12	14	16	18	20	22	24	26	28	30	32	34		
1	...	4	7 × 7	18	9	11	12	14	16	18	20	22	24	26	28	30	32	34	5,353	24,650
2 to 5	4	4	7 × 7	22	11	11	12	14	16	18	20	22	24	26	28	30	32	34	23,106	46,549
6	1	1	7 × 7	12	8	8	12	14	16	18	20	22	24	26	28	30	32	34	12,815	23,532
7 to 9	3	3	7 × 7	14	8	8	12	14	16	18	20	22	24	26	28	30	32	34	23,219	60,092
10 to 12	3	3	6 × 7	14	7	7	12	14	16	18	20	22	24	26	28	30	32	34	11,308	25,660
13 to 15	3	3	6 × 7	14	10	10	12	14	16	18	20	22	24	26	28	30	32	34	5,808	21,435
16 to 19	4	4	6 × 4	14	7	7	12	14	16	18	20	22	24	26	28	30	32	34	15,063	30,151
20 to 23	4	4	6 × 7	14	7	7	12	14	16	18	20	22	24	26	28	30	32	34	25,151	83,039
24 to 26	3	3	7 × 7	13	10	10	12	14	16	18	20	22	24	26	28	30	32	34	10,711	21,491
27 to 30	4	4	6 × 4	14	7	7	12	14	16	18	20	22	24	26	28	30	32	34	21,637	49,132
31	1	1	6 × 4	12	8	8	12	14	16	18	20	22	24	26	28	30	32	34	8,600	10,513
32 to 34	3	3	6 × 4	14	10	10	12	14	16	18	20	22	24	26	28	30	32	34	8,979	13,143

**TABLE IIIb. — Ropes 4, 3.5 and 3 millimetres (0.157, 0.138 and 0.118 inch) in diameter.**

1 and 2	2	4	7 × 7	22	11	0.4 (0.01575)	127 (18,630)	46	C-015 (0.005691)	2.5 (0.06843)	Hemp.	Soaked in tar oil. Ditto.	140 (5 1/2 in.) 140 (5 1/2 in.)	500 (1 ft. 10 1/8 in.) 500 (1 ft. 10 1/8 in.)	100 (280 lb.) 100 (280 lb.)	16.3 (23,180) 16.3 (23,180)	5,010	10,262
3	1	4	7 × 7	12	8	0.4 (0.01575)	122 (173,518)	41	0.0075 (0.002265)	2.5 (0.07874)	Ditto.						2,292	3,453
4 to 6	3	3	7 × 7	14	8	0.4 (0.01575)	121 (172,046)	47	0.01 (0.003394)	2.5 (0.10266)	Ditto.	Unsoaked.					4,939	8,913
7 to 12	6	6	6 × 7	14	7	0.45 (0.01575)	122 (173,518)	57	0.02 (0.00787)	2.5 (0.09365)	Ditto.	Soaked in tar oil. Ditto.	140 (5 1/2 in.) 140 (5 1/2 in.)	500 (1 ft. 10 1/8 in.) 500 (1 ft. 10 1/8 in.)	100 (280 lb.) 100 (280 lb.)	16.3 (23,180) 16.3 (23,180)	3,276	5,846
13 and 14	2	4	6 × 7	14	10	0.4 (0.01575)	144 (204,869)	47	0.0075 (0.002265)	2.5 (0.06843)	Ditto.						2,362	3,874
15 and 16	...	4	6 × 4	14	7	0.35 (0.01575)	121 (172,046)	35	0.02 (0.00787)	2.5 (0.06843)	Ditto.						2,721	5,562
17 and 18	2	5	6 × 7	14	7	0.35 (0.01575)	121 (172,046)	64	0.02 (0.00787)	2.5 (0.06843)	Ditto.						3,954	8,143
19 to 21	3	3	7 × 7	13	10	0.4 (0.01575)	126 (173,518)	48	0.005 (0.00197)	1.6 (0.0299)	Cotton.						3,456	5,106
22 and 23	2	3	6 × 4	14	7	0.4 (0.01575)	128 (173,518)	57	0.02 (0.00787)	1.6 (0.0299)	Cotton.						4,074	6,265
24	1	3	6 × 4	12	8	0.4 (0.01575)	121 (172,046)	31	0.005 (0.00197)	1.6 (0.0299)	Hemp.						2,063	2,223
25 and 26	2	3	6 × 7	14	10	0.4 (0.01575)	127 (180,630)	37	0.00394 (0.00394)	1.6 (0.0299)	Cotton.						1,864	2,450

In the case of the tests made by means of the machine shown in figures 2 and 3, as it was necessary, in order to obtain comparable results, to keep to one definite diameter of sheave, preference was given to sheaves 230 millimetres ( $9 \frac{1}{32}$  inches) in diameter. A certain number of ropes however were tested with sheaves 140 millimetres ( $5 \frac{1}{2}$  inches) in diameter, in order to obtain data to estimate what influence the diameter of the sheaves exercised on the wear of the ropes. It was found that the small sheaves often used where signals are operated by hand have a very destructive effect on the life of the ropes. Ropes used on sheaves 280 millimetres ( $11 \frac{1}{32}$  inches) in diameter lasted four to ten times as long as those used on sheaves 140 millimetres ( $5 \frac{1}{2}$  inches) in diameter. The reason for this will be considered later on.

Tables I to III show the results of the tests made, i. e. the mean values of the different comparative series of trials.

These results show that the strength of steel wire ropes varies within rather wide limits. Even in the case of ropes made in a similar way, material differences were found, which can only be due to the more or less suitable arrangement of the wires in the strands and of the strands in the rope. The pitch ratio, i. e. the ratio of the length of rope or of strand, in which the strand or wire makes one complete turn, to the diameter of the rope or strand, appears to exercise a material influence. The best results were obtained when the ratios were 13 to 14 for the strand, and 7 to 8 for the wire; as a rule that of the strand is twice that of the wire.

Generally speaking, the trials confirm the remark made by Professor Hrabák in his work <sup>(1)</sup>, that the greater the number of the wires and the smaller their diameter, the stronger is a wire rope. Another conclusion to be drawn from the results of the trials is that a necessary condition for making a good rope is to use quite homogeneous steel, of high ultimate tensile strength and having sufficient flexibility.

At present, in the specifications for steel wire rope, clauses are often inserted specifying that the wire used shall have an ultimate tensile strength of 100 kilograms per square millimetre (142,228 lb. per square inch), and attaching particular importance to the torsibility. This is based on the idea, correct in itself, that a wire rope must be as pliable as possible, so that it may readily adapt itself to the circumference of the sheaves, and that, therefore, too great tenacity must not be required, at the cost of the flexibility. But it is an error to assume that a pliable rope can only be made by using a wire which shows great strength in bending and great flexibility. It is forgotten that the wire has imparted to it very great flexibility by the double helical shape it has in the rope, and that this flexibility would amply suffice for all practical requirements, even if small sheaves were used, were it not that it was partly destroyed by the continual varying stresses in the wires and in the strands, and by the friction between different wires. It may be assumed with certainty that the wearing out of all the wire ropes used in actual practice is due to the continuous succession of tensile and compressive stresses to which the wires are subjected; the wires are compelled by these continuously alternating forces to make small movements relatively to each other. Now the friction between the wires resists these movements.

When the core of the rope is made of vegetable fibre, this reduces the friction of the wires to a certain extent and the wear becomes less, particularly if the core is

---

<sup>(1)</sup> *Die Drahtseile (Wire ropes)*. Berlin, 1902, J. SPRINGER.

soaked with some fatty substance which lubricates the wires from within and reduces the effect of friction.

The trials made have proved the correctness of this theory. The comparison of the life of the same cables when tested in the machine with sheaves of 230 and 140 millimetres ( $9\frac{1}{32}$  and  $5\frac{1}{8}$  inches) in diameter shows that with the smaller sheaves the ropes broke much sooner, because the wires were then compelled to make larger relative movements, opposed by greater friction. Moreover trials made on samples of ropes cut from the same coil of a roll showed that a rope which had been dipped in oil for several days stood nearly three times as many double bendings in the testing machine as rope not so treated. On examining the layer of zinc in the neighbourhood of the fracture of ropes broken in the machine, it was found that the zinc has disappeared there, and when it was immersed in the copper sulphate solution, a red coating quickly formed, whereas with wire taken from the same test piece but from a part where the rope had not been in contact with the sheave, several immersions were necessary. Thus the zinc had been removed, at the place where the rope broke, by friction.

It follows that in order to increase the life of cables, it is necessary to use a material resisting friction as much as possible, a material of high tenacity having at the same time sufficient flexibility. These qualities are only found united in the best cast steel.

The ropes which stood the greatest number of double bendings in the testing machine had an ultimate tensile strength of well over 100 kilograms per square millimetre (142,228 lb. per square inch), and great flexibility.

Hence it would be advisable, in specifications for the supply of steel wire rope, to specify the exclusive use of steel having an ultimate tensile strength of at least 120 kilograms per square millimetre (170,674 lb. per square inch), and capable of being bent forty times through an angle of  $180^\circ$  over a radius of 2.5 millimetres (0.09843 inch). It will then be certain that the manufacturer can only use best cast steel. Wire of inferior quality cannot have the specified tenacity unless it has less flexibility, or the specified flexibility unless it has less tenacity.

It cannot be considered advisable to specify the torsibility of the steel wire; for if the specifications give figures for this, the manufacturer will be tempted to use steel of medium quality. Galvanizing even the best and most tenacious cast steel, always has as unavoidable effect that the torsibility is more or less lost. This loss can no doubt be reduced by manufacturing the ungalvanized wire in a particular way, and thus obtaining wire which can be twisted a great number of times, but the other properties of the wire are injuriously affected.

Resistance to repeated torsion is not a quality which is specially desirable in wire to be used for making ropes, as the wire is subjected to torsion neither while the rope is made nor during its subsequent use. Mining authorities, who have drawn up special specifications for whim ropes, have already long ago given up inserting any clauses as to torsibility.

As regards the size of wire used for the ropes, the tables given above show that the best ropes are those made of the thinnest wires. The reason for this is that a rope on a sheave is subjected to a tensile stress on the outer side and to a compressive stress on the inner side in contact with the sheave. These different stresses produce small sliding movements of the wires relatively to each other. If the rope consists of a large number of very fine wires, it is evident that the relative movements of

adjoining wires are less than if the rope consists of a smaller number of thicker wires, and also that the wire will have more elasticity to counteract the forces acting on it.

In the case of the ropes tested, those made of wire 0.35 and 0.4 millimetre (0.01378 and 0.01575 inch) in diameter showed the greatest resistance to wear, whereas the ropes made of thicker wire gave unsatisfactory results.

It therefore is necessary, as Hrabák already showed, to have as fine wire as possible. Nevertheless there is a limit to this. In the first place, it is difficult to make very fine wire, and it will probably be not nearly so uniform. Secondly, it is necessary for each wire to have a certain cross-section, or else a small amount of wear or of exposure to weather will weaken it too much.

The diameter of 0.4 millimetre (0.01575 inch) is most suitable for wire-rope transmissions. As however there are difficulties in making a wire of exact size, a certain amount of fluctuation in the size may be allowed, but the wire must be quite homogeneous. It would, therefore, be to the advantage of both manufacturer and consumer to insert in the specification a clause that wire used for rope making shall have a diameter of not less than 0.37 millimetre (0.014567 inch) and of not more than 0.43 millimetre (0.016929 inch), galvanizing included.

As to the destructive effects of exposure to weather, it is important to protect the ropes against rusting. The bearing cross-section of the different wires forming a rope is small in absolute amount, while the surface exposed to oxidation is relatively large. All the more care is therefore required to protect the wires. They are, therefore, always galvanized. Zinc is much less liable to oxidation, by exposure to air, than steel; and of all the metals which may be used in this way, zinc has the greatest hardness.

The layer of zinc coating the steel wire must be sufficiently thick to prevent the oxidation of the rope during its ordinary life. The layer must on the other hand not be too thick, or else it would scale off owing to the bending it is subjected to in actual practice, and then the steel would not only be exposed, but the cracked surface would give rise to increased friction between adjoining wires.

It is particularly important that the zinc should not merely adhere to the surface of the wire, but that it should be effectively joined to the steel. For this reason, it is advisable to use the process in which the wire is heated to a low red heat and then passed through a solution of zinc in dilute hydrochloric acid, so as to obtain a chemically clean surface; then the wire is passed through a bath of melted zinc. The wire then becomes coated with a solid layer of zinc effectively joined to the steel. After the wire comes out of the zinc bath, it is passed through a layer of sand which removes the excess of zinc while still hot. By suitably adjusting the speed with which the wire passes through the zinc bath, and the distance between the bath and that layer of sand, the thickness of the layer of zinc may be varied as may be required.

Wire for ropes used for operating switches and levers should have a coating of zinc at least 0.01 millimetre (0.000394 inch) thick, and this must adhere so firmly to the steel that if the wire is wound in close coils round a mandril having a diameter ten times that of the wire, no scaling off takes place. A wire so galvanized can be immersed twice in the 20 per cent copper sulphate solution, each time for one minute, without showing a continuous layer of red copper.

The core of the cable wire ropes now mostly consist of hemp, instead of the wire formerly used. Cores made of steel wire have given only unsatisfactory results, and

their use is moreover, according to Professor Hrabák, wrong in theory. The ropes become heavier and more expensive, less flexible, unreliable and less durable. Now the object of the core is not merely to fill up the space available, but also to give the strands an elastic, non-rigid support, to enable them to yield to a certain extent to the forces acting on them and thus to reduce the destructive friction of the wires between themselves. Consequently the core must have a sufficiently large diameter so that each strand of the double-laid rope used for transmission is well in contact with the core. At the same time the fibres composing the core must be sufficiently solid to prevent any of the strands from shifting out of place and being forced into the core. The diameter suitable for a core thus depends on the diameter of the rope and on its pitch ratio. But it cannot be considered advisable to specify definite pitch ratios for strands and ropes; and just as much would it be premature to specify the diameter and construction of the core. For the consumer, all that need be specified is that the core shall be made of hemp. The use of Manilla fibre is to be prohibited, as these fibres are too coarse to be twisted up into fine strands. The core must be impregnated with an antiseptic liquid, free from acid, resisting the absorption of moisture. Under the strong pressure produced when the rope moves on the sheaves, this liquid is pressed in part into the strands and thus serves to lubricate the wires. The chief wire rope manufacturers already generally satisfy these conditions by soaking the core in tar oil. We may note that all the fats which of themselves would satisfy these conditions, cannot be used, as certain oils, *e. g.* neat's foot oil, exercise a destructive action on hemp fibre. The following would be reasonable clauses in specifying the cores of wire ropes to be used for transmissions:

- 1° The wire rope shall have a core of vegetable fibre, with which all the strands must be in contact;
- 2° Even under unfavourable conditions, the core shall not be destroyed before the rope;
- 3° The core shall not absorb moisture, nor shall it contain any acid whatever, or else the rope will oxidize from inside outwards;
- 4° The substance impregnating the fibre shall be a lubricant for the steel wires.

As regards the lay of the wires in the strands and the lay of the strands in the rope, respectively, these lays must be of different hand, so that the tendency for untwisting is neutralized. In the interests of uniformity it is advisable to specify that the strands should be laid up right-handed.

The tables giving the results of the trials show that of the ropes tested those having a diameter of 5 millimetres (0.197 inch) had the least strength. None of these latter satisfied the conditions which should have been specified. The best results were obtained with the one given under No. 10 of table IIa, with 36,654 double bendings round sheaves 230 millimetres ( $9\frac{1}{32}$  inches) in diameter; but this result is much inferior to that obtained with ropes 6, 4, 3.5 and even 3 millimetres (0.236, 0.157, 0.138 and even 0.118 inch) in diameter. We cannot give the definite reason for this surprising fact. Perhaps it is due to cables of a diameter of 5 and 6 millimetres (0.197 and 0.236 inch) being stiffer than the others, and that this disadvantage cannot be counteracted in 5 millimetre (0.197 inch) rope, as well as in the 6 millimetre (0.236 inch) rope, by using a large number of fine wires. In a 5 millimetre (0.197 inch) rope it

is hardly possible, unless the hemp core is unduly reduced, to have more than  $6 \times 12 = 72$  wires of the most suitable diameter (0.4 millimetre [0.01575 inch]). Now it seems that this number does not suffice to modify to the extent desired the excessive stiffness of the rope. However, it is hardly advisable to lay down the rule that 5 millimetre (0.197 inch) rope shall not be used for wire rope transmissions. A clause inserted in the specifications requiring that, in a given case, a rope subjected to a given tension shall stand a given number of double bendings round sheaves 230 millimetres ( $9 \frac{1}{32}$  inches) in diameter, before it breaks, will suffice to prevent the supply of ropes of inferior quality. If 5 millimetre (0.197 inch) ropes are in the future manufactured having the necessary strength, there is no reason to prohibit their use.

On the other hand, it is advisable to prohibit the use of rope having a smaller diameter than 4 millimetres (0.157 inch), although ropes 3.5 or even 3 millimetres (0.138 or even 0.118 inch) in diameter have shown a long life in the trials (*see* Nos. 17 and 18 of IIIb, 20 to 23 of IIIa, 22 and 23 of IIIb and 27 to 30 of IIIa). With these ropes the stress of 33 to 34 kilograms per square millimetre (46,935 to 48,358 lb. per square inch) is too great. Moreover this already large stress, which may attain 49 to 51 kilograms per square millimetre (69,690 to 72,536 lb. per square inch) when the pull on the transmission reaches (as sometimes happens) 150 kilograms (330 lb.), is too much increased as soon as one or more of the wires happens to give way, as generally not many wires are used; and consequently such thin ropes are affected by exposure to weather to an extent incompatible with the reliable working of the transmissions.

Therefore taking it altogether, ropes 6 and 4 millimetres (0.236 and 0.157 inch) in diameter must be pronounced as being most suitable for wire rope transmissions.

The 6 millimetre (0.236 inch) ropes can be made with a larger number of wires; there is the room necessary for a hemp core of suitable size, and owing to the larger diameter, the stiffness inherent to such a large rope can be reduced (*see* 8 and 9 of Ib, 11 to 16 of Ia, 11 and 12 of Ib, and 18 to 20 of Ia).

As regards 4 millimetre (0.157 inch) ropes, they have greater flexibility, owing to the very fact of their small diameter. Trials 1 and 2 of IIIb, 2 to 5 of IIIa, 4 to 6 of IIIb and 7 to 9 of IIIa show that these wires are suitable for operating signals and switches. The stress per unit of cross-section does not exceed the proper limits, and if suitably treated, these ropes will no doubt resist the action of the weather to the extent necessary.

Some of the 6 millimetre (0.236 inch) ropes stood well over 90,000 double bendings in the testing machine, and some of the 4 millimetre (0.157 inch) ropes well over 60,000. It is evident that such high figures cannot be specified, but it is quite reasonable to specify that wire ropes used for transmissions shall stand at least 40,000 double bendings before breaking, such tests being made by means of the machine shown in figure 4, the rope being subjected, while the tests are being made, to a tensile stress of 100 kilograms (220 lb.), the wire rope to travel 500 millimetres (1 ft.  $7 \frac{21}{32}$  in.) round sheaves of the usual diameter of 230 millimetres ( $9 \frac{1}{32}$  inches). Then the works could only supply wire rope of the best quality.

We are unable to recommend that the number of wires in the rope, or any given method of manufacture, should be specified. The chief points, mentioned above *supra*, in



of irreproachable quality it is necessary to use the best materials and conscientious workmanship and to pay careful attention to numerous details in the manufacture; a suitable system of construction is also necessary. Hence the supply of wire ropes will always be a matter of confidence.

When wire ropes for transmissions are to be ordered, it is not enough to issue a strict specification. Among the many works manufacturing wire ropes those must be selected, with the greatest care, which are the most efficient. They alone will be able to satisfy the requirements enunciated above.

---

## TESTS OF WESTINGHOUSE BRAKES FOR FAST TRAINS, MADE ON THE BAVARIAN STATE RAILWAY.

(NOTE COMMUNICATED BY THE ADMINISTRATION OF THAT RAILWAY.)

---

Figs. 1 to 4, pp. 1056 to 1058.

---

(*Organ für die Fortschritte des Eisenbahnwesens.*)

---

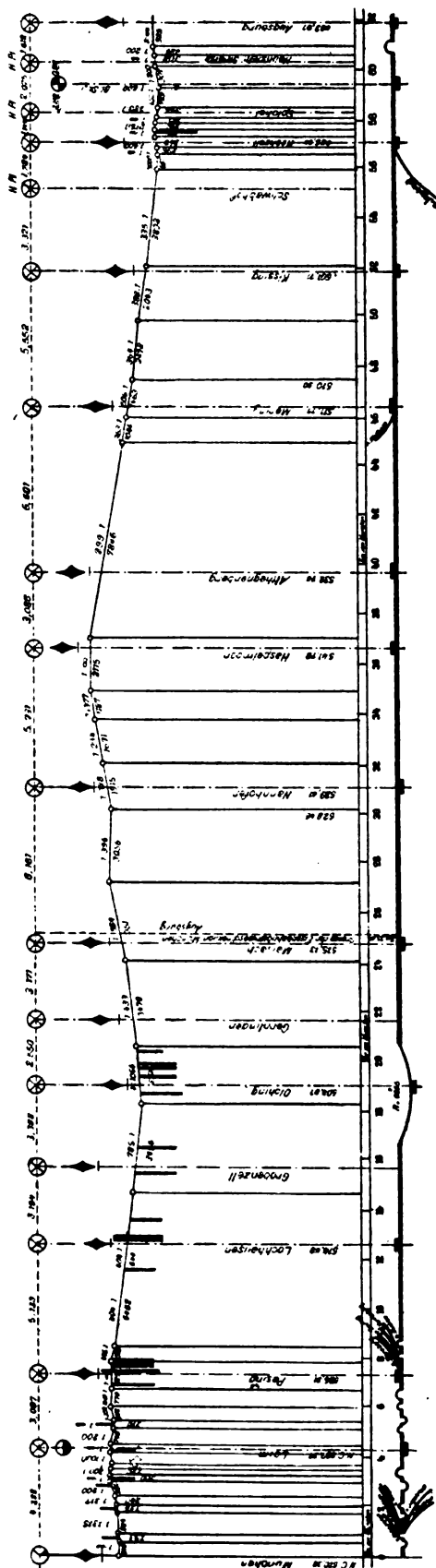
The present general tendency towards increasing the speed of express trains leads to the search for new improvements in brake gear, so that the distance within which a stop can be effected may, even at very high speeds, remain within the limits which safety requires.

It is well known that compressed air brakes in which the air pressure in the brake cylinder remains constant, while the brakes are on, are not satisfactory at very high speeds. On the one hand the friction between the brake block and the wheel becomes appreciably reduced as the speed increases, and on the other hand the maximum pressure in the brake cylinder is limited; it must be adjusted so that towards the end of the braking, when the friction is greatest, no wheels shall become locked. It is for this reason that Westinghouse adopted a higher pressure in the main pipe of the brake known as the high speed brake, very extensively used in America for express trains. In this way a high initial pressure is obtained in the brake cylinder, which subsequently is gradually reduced towards the end of the braking to the extent required to avoid locking the wheels; automatic reducing valves are used for this purpose.

Another application of the same principle is made in the *Schnellbahn-Bremse* (brake for express lines) which the Bavarian State Railway has been trying on a test train, at the request of the Westinghouse Company of Hanover.

### *Description of the new "Schnellbahn-Bremse".*

In the new brakes the pressure in the main pipe remains the same as before; but the difficulties which would result from any increase in the



**Fig. 1. — Profile and plan of the Munich-Augsburg line.**

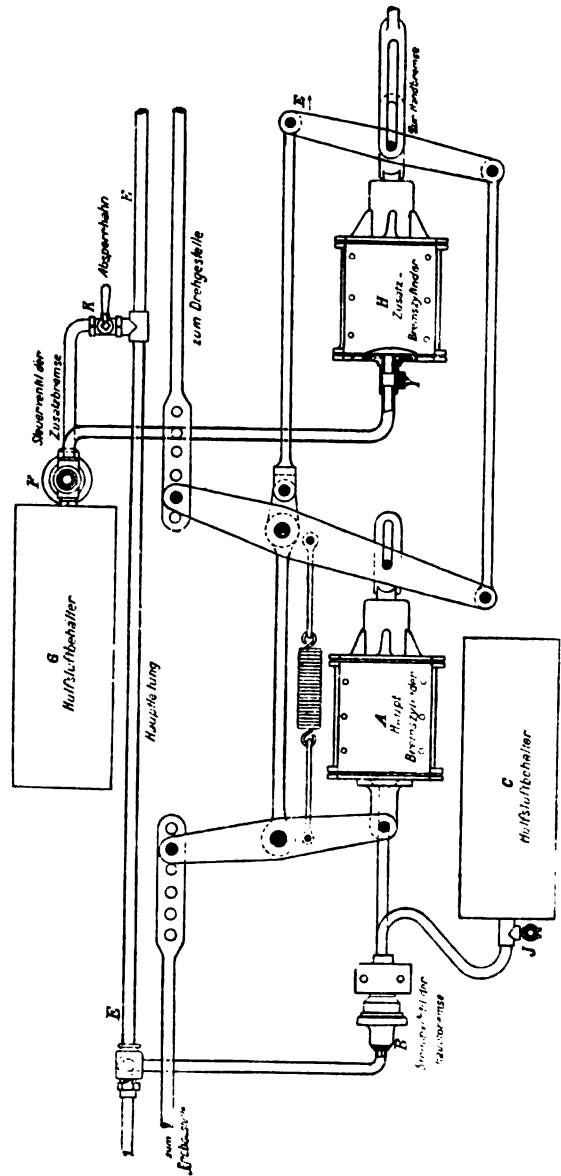


Fig. 2. — Arrangement of the Westinghouse brake for express lines.

**Explanation of German terms:** (A) Hilfsluftbehälter = (G) Auxiliary reservoir. — (F) Steuerventil der Zusatzbremse = (F) Triple valve of secondary brake. — (K) Absperrhahn = (K) Cut-out valve. — Zum Dreigestelle = To the bogie. — Hauptleitung = Main pipe. — (B) Steuerventil der Hauptbremse = (B) Triple valve of main brake. — (A) Haupt-Bremszylinder = Main brake cylinder. — (H) Zusatz-Bremszylinder = (H) Secondary brake cylinder. — / zur Handbremse = To the hand brake. — (C) Hilfsluftbehälter = (C) Auxiliary reservoir.

pressure are avoided. In addition to the ordinary gear of the quick-acting brake (fig. 2) which consists mainly of the brake cylinder A, the quick-acting triple valve B and the auxiliary reservoir C, there is a secondary brake cylinder H, with an auxiliary reservoir G, and a triple valve F, which supplies the extra brake power at high speeds. Both the chief brakes and the secondary brake are supplied with air through the main pipe in the usual way and act on a single brake gear.

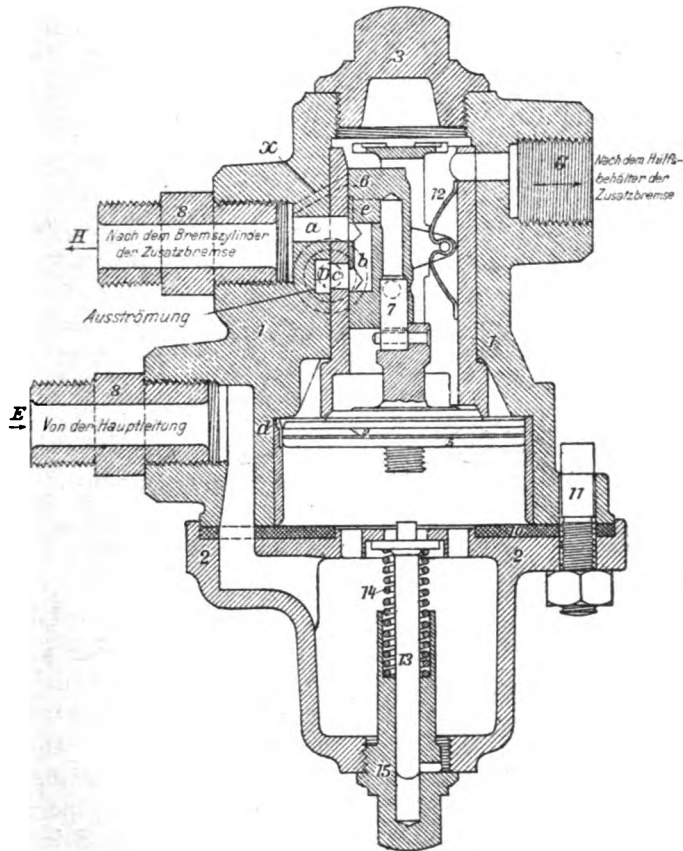


Fig. 3. — Ordinary triple valve F of secondary brake.

**Explanation of German terms :** (H) Nach dem Bremszylinder der Zusatzbremse = (H) To the cylinder of the secondary brake. — (G) Nach dem Hilfsbehälter der Zusatzbremse = (G) To the auxiliary reservoir of the secondary brake. — Ausströmung (D) = Exhaust (D). — (E) Von der Hauptleitung = (E) From the main pipe.

The valve F of the secondary brake, shown in section in figure 3, differs from the ordinary Westinghouse triple valve, only in having an opening  $x$

in the face of the slide, forming a passage between the auxiliary reservoir and the cylinder when the main piston 5 moves the slide 6 into the position for braking. The secondary brake cylinder also communicates with the outer air through the opening *y* (fig. 2). While the chief brake always works in the usual way, the secondary brake hardly comes into play in the case of ordinary stops. It is true that every time the pressure in the main pipe is reduced, compressed air passes from the auxiliary reservoir into the secondary brake cylinder, but that air then enters slowly, escapes at once into the outer air through the opening *y* and as soon as the reduction of pressure in the main pipe ceases, the valve *F* returns to the « brakes off » position. In case of an emergency stop the chief brake cylinder and the secondary brake cylinder both act at once with full power, as the pressure

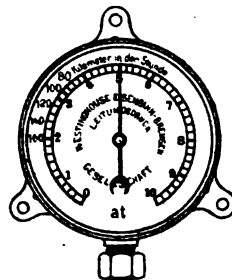


Fig. 4. — Air and speed gauge carried on the locomotive.

*Explanation of German terms :* Kilometer in der Stunde = Kilometers per hour.  
Leitungsdruck = Pressure in main pipe.

in the auxiliary reservoirs and the corresponding brake cylinders at once become equal. But as the air escapes through the opening *y*, the pressure in the secondary cylinder becomes gradually reduced till it equals the pressure left in the main pipe. The valve *F* then acts automatically and completely releases the second brake. It follows that when emergency stops have to be made, the action of the secondary cylinder can be kept going for a longer or shorter time, according as the pressure in the main pipe remains more or less considerable. It is owing to this reduction of pressure in the secondary cylinder (which reduction at first takes place slowly, then more and more quickly) that the brake pressure varies in accordance with the coefficient of friction, so that the retardation remains practically uniform the whole time the brakes are on. In order to make it easier for the driver to manipulate the brake, the air gauge has a second graduation showing, for the different speeds, to what extent the pressure in the main pipe has to be reduced so that the secondary cylinder may act in proper time (fig. 4).

*Equipment of test train.*

The test train consisted of an express compound locomotive with ten wheels, four coupled, weighing 68·3 tons (67·2 English tons) in running order, together with an eight wheeled tender, weight loaded 50 tons (49·2 English tons), and four to six corridor carriages, eight wheeled, tare 36·5 tons (35·9 English tons) each. With the ordinary Westinghouse brake, the brake ratio was 51 per cent on the bogie and 65 per cent on the driving wheels, which corresponded to about 60 per cent on the whole locomotive when in full running order. The secondary brake cylinder, 380 millimetres (1 ft. 2 <sup>15</sup>/<sub>16</sub> in.) in diameter, raised the total brake pressure to 70·6 tons (69·5 English tons), *i. e.* to 103 per cent of the weight in running order. The tender weighed 22 tons (21·7 English tons) empty, and could take 6 tons (5·9 English tons) of coal and 22 cubic metres (4,840 English gallons) of water; besides the ordinary brake cylinder, 305 millimetres (1 foot) in diameter, giving a brake pressure of 70 per cent of the weight when half full, it was equipped with a secondary cylinder of the same diameter; the brake ratio was in this way increased to 130 per cent of the said average weight. The carriages were also equipped with a quick-acting brake with cylinders 305 millimetres (1 foot) in diameter, and with a secondary cylinder 355 millimetres (1 ft. 1 <sup>31</sup>/<sub>32</sub> in.) in diameter raising the brake pressure from 72 to about 160 per cent of the tare. The brake gear had been suitably strengthened, in order to avoid any loss of pressure from the springing or giving way of any of the parts. The brake blocks were 450 millimetres (1 ft. 5 <sup>11</sup>/<sub>16</sub> in.) long.

The Kapteyn apparatus for recording the pressures in the cylinders had been installed in one of the carriage compartments. In order to determine the speed and the distance in which a stop was effected with accuracy, a three lever recorder, with seconds pendulum, was used; this was lent by the *Studien-Gesellschaft für elektrische Schnellbahnen* to the Westinghouse Company.

*Tests.*

The trial run was made on July 8, 1905, on the line from Munich to Augsburg, profile and plan of which are shown in figure 1. On the outward journey, the train consisted of the locomotive and its tender and four carriages, representing a weight of 250·4 tons (246·4 English tons); on the return journey two carriages were added, thus increasing the weight to 323·3 tons (318·2 English tons). The tender is reckoned as 36 tons (35·4 English tons), its weight half full. Emergency stops were made at speeds of 30, 50, 70, 90, 100, 110, 120 and 130 kilometres (18·6, 31·1, 43·5, 55·9, 62·1, 68·4, 74·6 and 80·8 miles) per hour, and ordinary stops at sundry

Index number.	TYPE OF BRAKE.	COMPOSITION OF TEST TRAIN.		Pressure in main pipe, atmospheres.	PROFILE OF TRIAL SECTION.		Speed of train, in kilometres (in miles) per hour.	Time required for stopping, seconds.	LENGTH OF STOP		Mean retardation, in metres (in feet and inches) per second.	Remarks.
		Locomotives.	Carrriages.		actual, in metres (in yards).	reduced to horizontal, in metres (in yards).						
Outward journey : MUNICH TO AUGSBURG.												
1	Express line brake ( <i>Schnellbahn-Bremse</i> ) .	1	4	5	Descent of 2.47 per mil. . . .	119 (73.9)	31.50	550 (602)	536 (586)	1.05 (3 ft. 5 5/8 in.)		
2	Ordinary quick-acting brake . . . . .	1	4	5	Ascent of 2.3 . . . . .	120 (74.6)	41.50	741 (810)	765 (837)	0.80 (2 ft. 7 1/2 in.)		
3	— — — — —	1	4	5	— of 1.77 . . . . .	71.6 (44.5)	20.50	298 (328)	241 (264)	0.97 (3 ft. 2 3/8 in.)		
4	Express line brake ( <i>Schnellbahn-Bremse</i> ) .	1	4	5	— of 2.5 . . . . .	71.5 (44.4)	15.50	165 (180)	169 (185)	1.28 (4 ft. 2 3/8 in.)		
5	— — — — —	1	4	5	— of 2.5 . . . . .	53 (32.9)	14.25	125 (137)	120 (141)	1.03 (3 ft. 4 3/8 in.)		Weather : fine. Wind : slight. Rails : dry.
6	— — — — —	1	4	5	— of 3.1 . . . . .	36 (22.4)	8.75	54.5 (59.6)	56.5 (61.8)	1.14 (3 ft. 8 7/8 in.)		
7	— — — — —	1	4	5	Descent of 3.34 . . . . .	120.5 (80.5)	33.25	622 (680)	602 (658)	1.08 (3 ft. 6 1/2 in.)		
8	Ordinary quick-acting brake . . . . .	1	4	5	— of 2.57 . . . . .	131 (81.4)	50.00	988 (1,081)	951 (1,046)	0.73 (2 ft. 4 3/8 in.)		
Return journey : AUGSBURG TO MUNICH.												
9	Express line brake ( <i>Schnellbahn-Bremse</i> ) .	1	6	5	Ascent of 2.98 per mil. . . .	90.3 (56.1)	19.75	258 (282)	264 (289)	1.27 (4 ft. 2 in.)		
10	Ordinary quick-acting brake . . . . .	1	6	5	— of 2.75 . . . . .	91.7 (57.0)	27.75	398 (435)	411 (449)	0.92 (3 ft. 1/8 in.)		
11	— — — — —	1	6	5	Descent of 3.4 . . . . .	100.1 (62.2)	33.75	530 (580)	507 (554)	0.83 (2 ft. 8 1/8 in.)		
12	Express line brake ( <i>Schnellbahn-Bremse</i> ) .	1	6	5	— of 2.5 . . . . .	99 (61.5)	21.25	316 (346)	309 (338)	1.30 (4 ft. 3 3/8 in.)		
13	— — — — —	1	6	5	— of 2.3 . . . . .	109.5 (68.0)	27.25	446 (488)	436 (477)	1.12 (3 ft. 8 1/8 in.)		
14	Ordinary quick-acting brake . . . . .	1	6	5	Ascent of 1.27 . . . . .	109.7 (68.2)	35.50	598 (654)	608 (665)	0.86 (2 ft. 9 7/8 in.)		Weather : fine. Wind : slight. Rails : dry.

speeds. By way of comparison, emergency stops were also made with the ordinary brake at speeds varying from 70 to 130 kilometres (43·5 to 80·8 miles) per hour, the secondary brake having been put out of action by means of the cut-out valve *k* (fig. 2). In every case the brakes went on smoothly and no shocks were produced. The table given herewith shows the results obtained in the emergency stops which were all made while running on the straight.

The distances within which stops were effected with this new brake are the shortest which have ever been recorded in Germany during high speed runs; and that although only a small part of the surface of most of the new brake blocks became applied to the tires. The considerable influence this has is well shown by the stops effected by the ordinary quick-acting brake, which are not nearly so good as those found in former tests, made under analogous conditions. As for the distances within which stops have been made with the new type, they are as a rule, even at slow speeds, about 30 to 35 per cent less than with the ordinary quick-acting brake. The use of the new brake, which has a very simple construction and is very easy to operate, thus has appreciable advantages in the case of the express speeds now usual.

As the vehicles of the test train could no longer be spared, owing to the heavy summer traffic, test runs with the blocks well ground in could not be made in July. It is therefore proposed to resume the tests later on, and then also give the representatives of other railways an opportunity of being present at the trial runs.

---

## SOME REMARKS ON THE SUBJECT OF THE MUNICH TRIALS OF FAST TRAIN BRAKES,

By J. DOYEN,

CHIEF ENGINEER OF THE BELGIAN STATE RAILWAY.

The *Schnellbahnbremse* considered in the preceding article is the third attempt made by the Westinghouse Company to improve the braking of fast trains by allowing for the variation in the coefficient of friction.

The question is of paramount importance, and as modern requirements, without awaiting its solution, make it necessary for railway companies continuously to increase the speed of their trains, we think that all ideas which might help to solve the problem should be brought forward and discussed without delay.

The first Westinghouse apparatus <sup>(1)</sup> made the greater brake block pressure at high speeds depend on the magnitude of the coefficient of friction between the blocks and the wheels; thus it established automatically a direct relation between the speed of the train and the pressure. This was a rational solution; but unfortunately the apparatus did not give the expected results. We shall see subsequently that the hope of obtaining a solution in this way has not been abandoned.

The second apparatus is the high speed brake, the arrangement of which is well known. Its action depends purely on time, that is to say its effect is constant, whatever the speed of the train at the moment the brakes are applied. If the time the additional pressure on the blocks is applied is suitably adjusted for speeds of say 110 to 120 kilometres (68·4 to 74·6 miles) per hour, then it is necessarily too long for lower speeds and when speeds of 70 to 80 kilometres (43·5 to 49·7 miles) per hour are reached, wheels become locked; and this is highly objectionable from every point of view.

I do not, in this connection, lay any particular stress on any excessive strains produced on the couplings, as such arise in all questions in connection with braking; such must be met by the construction of the couplings themselves quite independently of the question of brakes. In this connection, I may mention the Westinghouse friction draft gear.

---

<sup>(1)</sup> See Douglas Galton's paper : *On the effect of brakes on railway trains*, published in the *Proceedings of the Mechanical Engineers* (June, 1878) and reprinted since.

In spite of the success the high speed brake has had in America, the defect just referred to has induced the Westinghouse Company to seek for improvements, and it at present recommends a new express line brake, which the Germans call *Schnellbahnbremse*; this has been tried on the Bavarian State Railway and will be further tested next spring.

We cannot sufficiently praise the initiative of the Bavarian State Railway which is always to the front when any new question relating to brakes turns up; but the trials made, at least as described in the *Organ* article, reproduced above, give rise to several criticisms which it seems to us incumbent to formulate before the tests next spring; for these tests can, if it is considered advisable, supply proof as to whether our criticisms are correct.

The principle on which the new brake is based is to proportion the time extra pressure is applied to the brake blocks to the reduction of pressure in the main pipe; this enables the driver to regulate the action of the *Schnellbahnbremse* according to the speed of the train. The idea has a good deal in it, and is worthy of careful consideration, but the arrangement adopted has one serious objection to it. The air gauge with the speed graduation is no doubt a very good instrument under normal conditions; but it is unfortunately very doubtful if it would be of use in times of danger.

This is a very important point worth attention. We are quite ready to admit that this special gauge will enable the driver, when in the calm frame of mind induced by normal conditions, to regulate the action of the brakes according to the speed; thus there is nothing surprising in the fact that under such normal conditions (and under such the tests were made) the distance within which a stop was effected was reduced 30 per cent. It is very evident that this would be a great advantage as regards the drawing up of time-tables, the regular running of trains and the reduced distance of the visibility of signals.

But what will happen if an unexpected obstacle suddenly confronts the driver? Is it reasonable to expect him to be so calm and have so accurate a touch that he will grasp what the speed is even approximately, and that he will adjust the brake so that the needle will point to the division required? And even if he has this calmness and this accuracy of touch, is it not *a priori* certain that precious time will be lost by replacing the sudden instinctive operation of the brake valve, by a calculated, accurate and consequently relatively slow movement.

The future tests at Munich could, therefore, very usefully elucidate the following points :

a) What time elapses between giving a driver a sudden unexpected order to make an emergency stop, and the moment the brakes are on full :

1° In the case of an emergency stop with the old quick-acting brake;

2° In the case of an emergency stop properly carried out with the *Schnellbahnbremse*?

This test, if repeated a sufficient number of times, will alone make it possible to determine the practical importance of the *time lost* with the new brake. It is to be noted that this loss is at the most unfavourable moment, *i. e.* when the train is running at high speed.

b) What would happen at the different speeds of say 120 to 60 kilometres (74.6 to 37.3 miles) per hour, if the driver were to lose his head and operate the quick action by quite or nearly emptying the main pipe?

It is particularly at the low speed of 60 to 70 kilometres (37.3 to 43.5 miles) per hour that the latter test would be of interest, for it is more particularly at points where speed is reduced, at crossings or approaches to large stations, complicated junctions, etc., that danger is most likely to turn up suddenly, when a loss of two or three seconds might have the most serious consequences.

It is also possible that the new brake may have defects of a secondary character, which may not become apparent except with long trains which have already been running for some time, and will consequently certainly not have become apparent to the Bavarian observers. It is by no means unusual for trains of sixteen carriages to attain a speed of 110 kilometres (68.4 miles) per hour; a proper system of high speed braking must, therefore, also work properly in the case of long trains. Now :

1° The *Schnellbahnbremse* has the defect of expending air absolutely uselessly in the case of ordinary service stops. As this air has to be replaced while the brakes are taken off, the latter period becomes longer and the brake consequently become less easy to work;

2° The triple valves (F) require very careful maintenance; for the least slowness of movement of this appliance while the brakes are being taken off, may have a serious effect on the possibility of graduating the action of the brake.

Taking it altogether, however ingenious the appliance devised by the Westinghouse Company to allow for the variation of the coefficient of friction may be, the Munich tests leave grave doubt as to its practical value.

In addition to its evident qualities, the *Schnellbahnbremse* has doubtful points which require very careful examination. In the present state of the problem, it is at least certain that this brake is by no means a final solution; in our opinion this solution should rather be looked for in the rational direction of automatically regulating the brake block pressure.

An extremely interesting attempt in this direction was made by Messrs. Sie-

mens and Halske, at the time of the high-speed trials between Berlin and Zossen.

It is well known that a heavy pendulum freely hung in a running train does not hang vertically when there is any positive or negative acceleration, but forms an angle, with the vertical, proportional to the acceleration, the bob being behind the vertical when the acceleration is positive, and in front when this is negative. A valve, placed at such a distance in front of the vertical, that when touched and consequently opened by the bob as soon as the maximum negative acceleration was reached, could be utilized to take off the extra pressure.

Now whatever may be the initial speed of braking, the maximum retardation always depends on the increase of the coefficient of friction. The pendulum would thus make it possible to take off pressure at the moment when the coefficient of friction become such that there was a danger of locking the wheels.

This method is such a good and rational one that it deserves further investigation, in spite of its comparative failure at Zossen.

Each time the acceleration varies, the pendulum, before stopping in the position corresponding to the new acceleration, makes a series of oscillations during which it swings more or less beyond the position of equilibrium. Desdovits has called this quantity the *lancé* (the throw) of the pendulum, and it is probable that the irregular action observed at Zossen was due more or less to this. If this is the case, it would be easy to make it practicable to use a pendulum.

I have tried to devise an apparatus the working of which depends directly on the speed of the train.

The following is the principle which at present has only been the subject of a preliminary examination and which I should be happy to see worked out by those who have brought the manufacture of brakes to so high a state of perfection.

By means of a cylinder having its piston operated by a train axle, air is compressed in a cylinder of given capacity; the air is constantly escaping from this cylinder by means of a very small hole of suitable size. It follows that the pressure in the cylinder depends at any given time on the speed of the train; consequently, it would be easy to design a system of valves which would take off the excess brake block pressure as soon as the pressure in the reservoir, or what comes to the same thing, as soon as the speed of the train had become reduced to the point fixed in advance.

---

## NEW ARMoured PICKLED WOOD BEDPLATE,

By X.

---

Figs. 1 to 6, p. 1068.

---

Count Joseph Borini, manager of the Reggio Emilia Railway, has proposed a new pattern of bedplate for Vignoles rails, for use on wooden sleepers <sup>(1)</sup>. It consists of a tablet of pickled wood (fig. 1) and of a metal plate which forms the armouring. There are right-hand and left-hand patterns (figs. 2 and 3) which only differ in the position of the holes in the armouring, but the same tablet is used in both cases. When a sleeper has become decayed around the holes, or these have become too large, the two patterns can be interchanged, new holes being made in the sound wood.

The tablet is rectangular; there are two holes for the spike and the screwspike; the lower face is horizontal and the upper face slopes downwards, at an angle of 1 in 20, towards the inside of the track.

Leaving out of consideration foreign hardwoods which are very suitable, but cannot be used on account of excessive cost, the most suitable wood is beechwood, which is inexpensive, has a long life and well resists hammering and crushing. Whatever wood be used, it must be sound, well-seasoned, and free from any defect. It must be cut so that the fibre in the tablet runs crosswise to the track.

Elm and poplar may also be used; but poplar has a much shorter life than elm and beech.

The tablets are cut 5 millimetres ( $\frac{3}{16}$  inch) thicker than they will be in actual use; they are reduced to the right size after they have been pickled in a boiling bath of tar or of carbolineum. The latter is the more expensive pickle, but it is also more effective. The wood may also be pickled before it is cut up into tablets.

The metal armouring plate which holds the wood is made in one piece; it has two holes corresponding to those in the tablet, and is constructed so that the flange of the rail rests only on the latter and is not in contact with the plate except at its turned-down edges. All the plates must be made exactly to gauge.

---

<sup>(1)</sup> A description of it is given in a pamphlet published by the author.

Trials were made with armouring plates made of cast iron, wrought iron and steel, but the two former are not strong enough to be used.

The armoured plate is placed in the same position as the ordinary bedplate (see fig. 6), but only the underside of the wood rests on the sleeper.

At present the cost of an armoured plate is greater than that of the iron plate generally used, but if there was sufficient demand to justify laying down special plant for making armoured plates, these might very probably compete well with iron plates.

The life of the tablets may be estimated from that of pickled beech sleepers; these only have to be replaced after from twenty to twenty-five years of service. Now as the tablets can be made of much better quality, it is only reasonable to assume that their life, and consequently that of the whole plates (of which they form the weakest part) will not be much less than that of the usual metal bedplates.

When new sleepers are put in, the bedplate can be removed without any damage to the tablet, which is protected by the armouring; and the bedplate can be used over again on the track.

It is easy to ascertain the condition of such an armoured plate, and to see when it becomes necessary to renew it, either wholly or partially. A new tablet must be put in when for any reason the upper surface of the wood is no longer higher than the turned down edges of the armouring plate, for then the pressure of the rail detaches the tablet from the armouring. As a rule, the upper surface should project 4 millimetres ( $\frac{5}{32}$  inch), that is three times as much as the tablet will give under the heaviest loads the track can bear. It is however not advisable to wait, with the renewal of the tablet, till the projection has become nil; a little attention on the part of the permanent way men will soon enable them to see when this operation is best carried out.

After some general considerations on the advantages of bedplates as compared with the system of having the rails in direct contact with the sleepers, the author draws comparisons to show the superiority of his armoured bedplates to the ingot iron or mild steel plates generally used.

The seat of the armoured plate on the sleeper has a larger area, and owing to the compressibility of the tablet the surfaces in question are kept in better contact.

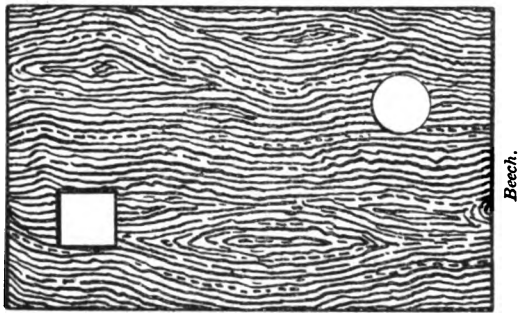
The depressions which metal plates hammer into sleepers are avoided; such depressions are very much marked if the sleepers are of wood softer than oak.

The fastening securing the rail to the sleeper is improved, consequently smoother rolling results.

The gauge of the rails is maintained better, owing to the great stiffness which results from the better contact between the rail, the wooden tablet of the armoured plate and the sleeper.

The edges of the armouring protect the spikes and screwspikes better against the direct action of the flange of the rail, also owing to the greater stiffness of the

*Plan.*



*Cross-section.*



Fig. 1. — Pickled wood tablets.

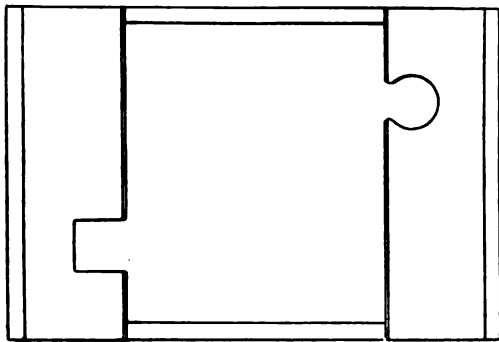


Fig. 2. — Plan of armouring.

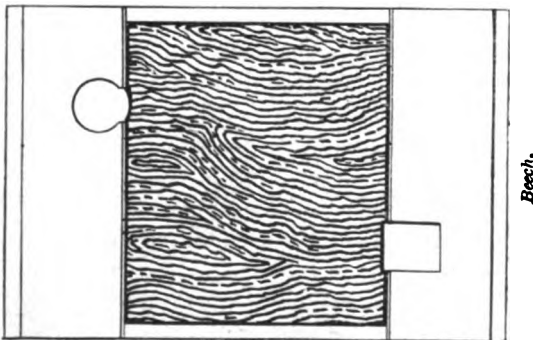


Fig. 3. — Plan of armoured bedplate.

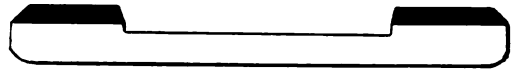


Fig. 4. — Cross-section of armouring.

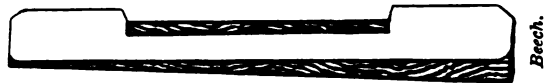


Fig. 5. — Side view of armoured plate.

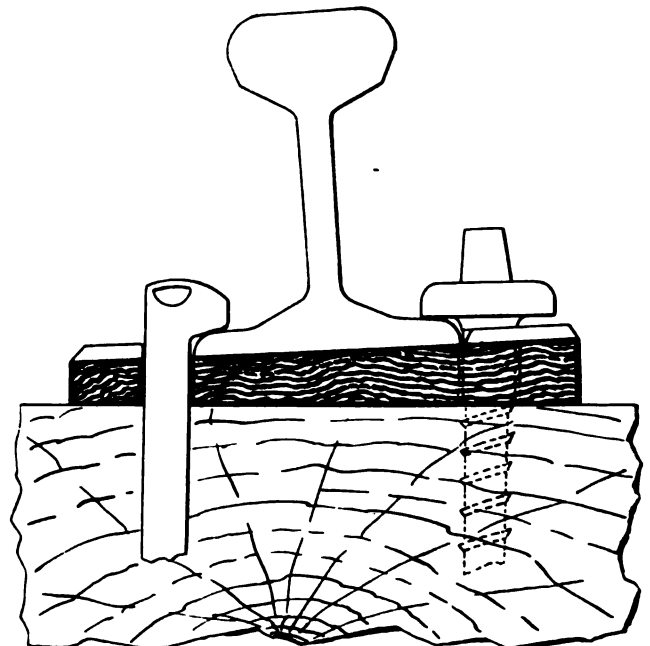


Fig. 6. — Cross-section of rail and armoured plate fixed to sleeper.

Figs. 2 to 5. — Armouring and armoured plate.

fastening. The life of the spikes and screwspikes is also improved by their lubrication by the pickle which is squeezed out of the tablet by the pressure of the rail when a train passes.

The same action tends to the pickling of the sides of the holes in the sleepers; this prevents the decay of the wood at those places. Sleepers have often to be taken out from the track on account of such decay.

Owing to the much better contact between the sleeper and the tablet, it is more difficult for wet to work into the holes than when ordinary plates are used.

A bedplate which consists entirely of metal is subjected, when trains pass, to vibrations which strain the fastenings and accelerate the destruction of the sleepers.

This disadvantage does not exist in the case of the armoured plate, for the following reasons :

1° The pickling of the wood round the holes in the sleepers, referred to above, increases the resistance to the displacement and to the drawing of the spikes and screwspikes;

2° As there is better contact between metal and wood than between metal and metal, the vibrations are less; this improves the stiffness of the fastening;

3° The supporting surfaces are materially larger, so that the load on the sleeper is better distributed;

4° Owing to the compressibility of the wood, the tablet is always in contact with the sleepers and the bottom of the rail; the angle therefore remains constant;

5° This compressibility of the tablet neutralizes part of the stresses which would otherwise be transmitted to the sleeper;

6° As the armoured plate is larger, it forms a better protection for that part of the sleeper which it covers, which is the part most liable to deterioration. This protection is the more effective the better the contact between the tablet and the sleeper.

This is a very important advantage, as sleepers have often to be taken out because the wood is decayed near and below the bedplate, on the inner side, particularly in cases where ballast is not readily permeable.

Some trials of these plates have been carried out on standard gauge lines belonging to the Italian State.

The first trials were made in the open track, on a curve with a radius of 250 metres (12  $\frac{1}{2}$  chains), at a place where the trains run at 40 kilometres (24·9 miles) per hour. The trains consist of cars having axle-loads of 12 to 13·5 tons, and are hauled by six-wheel locomotives weighing 34 tons. The plates were left uncovered during the whole summer of 1904, in order to allow the weather to exercise its full effect.

The highest and lowest temperatures recorded during the year were +36° and -12° C. (+97° and +10·4° Fahr.).

No change could be detected in the plates after a year; the fastening of the rail, plate and sleeper was as stiff as on the day it was made.

Other trials made on a 2,000 metre (100 chains) curve as well as on the track going from Reggio station to the loco sheds gave similar results.

These observations only extend over a comparatively short time and over rather short sections of line; nevertheless, the excellent results obtained lead to the expectation that the plates will have a sufficiently long life to make the general adoption of the system advisable.

---

# PROCEEDINGS

OF THE  
SEVENTH SESSION

WASHINGTON : MAY, 1905

---

## 1<sup>st</sup> SECTION — WAY AND WORKS.

---

[ 624 .63 & 721 .9 ]

### QUESTION IV.

---

## CONCRETE AND IMBEDDED METAL

---

*The use of concrete strengthened by the use of imbedded metal in railway work.*

*Comparison, from the point of view of cost, of bridges of concrete strengthened by the use of imbedded metal, with those of metal.*

#### *Reporters :*

*America.* — Mr. J. F. WALLACE, late general manager, Illinois Central Railroad, chief engineer Panama Canal Commission.

*Russia.* — Mr. Serge DE KAREISCHA, conseiller d'État, professeur à l'École des voies de communication, vice-directeur du département de l'exploitation à l'Administration des chemins de fer de l'Empire russe, président du bureau des conférences consultatives des ingénieurs de la voie.

*Other countries.* — Mr. W. AST, conseiller de régence, directeur de la construction du chemin de fer autrichien Nord Empereur Ferdinand.

---

## QUESTION IV.

---

## CONTENTS

---

	Pages.
Sectional discussion . . . . .	1073
Sectional report . . . . .	1090
Discussion at the general meeting . . . . .	1090
Conclusions . . . . .	1095

### PRELIMINARY DOCUMENTS.

Report No. 1 (Russia), by Serge DE KAREISCHA. (See the *Bulletin* of February, 1905, 2<sup>nd</sup> part, p. 893.)

Report No. 2 (all countries, except Russia and America), by W. Ast. (See the *Bulletin* of February, 1905, 1<sup>st</sup> part, p. 363.)

Report No. 3 (America), by J. F. WALLACE. (See the *Bulletin* of February, 1905, 1<sup>st</sup> part, p. 451.)

Vide also the separate issues (in red covers) Nos. 27 and 35.

---

## SECTIONAL DISCUSSION

---

Meeting held on May 10, 1905 (afternoon).

---

MR. PONTZEN, VICE-PRESIDENT, IN THE CHAIR.

**The President.** (In French.) — Messrs. de Kareischa and Ast having been unable to come over from Europe, Messrs. Kupka and Tolstopiatoff have been kind enough to undertake drafting some conclusions, summarizing the three reports. They were unable to meet Mr. Wallace, the third reporter, but we hope that he will be able to take part in the discussion.

I now call upon Mr. Kupka to summarize Mr. Ast's paper.

**Mr. Kupka,** Kaiser Ferdinand Nordbahn, Austria. — Well, gentlemen, my colleague and friend, Mr. Ast, who did not cross the Atlantic because of his delicate health, asked me to represent him and to read you the paper, the summary of subject 4, the question concerning concrete and imbedded metal.

The very good results obtained, during the last ten years or so, by the use of armoured concrete for structures of all kinds, led the committee of the International Railway Congress at its seventh session now being held in Washington, to put the question whether this system of construction could be applied with advantage, both technically and economically, to railway work.

The reporters appointed for the purpose have issued their reports, which are based on the answers kindly given by the railways belonging to the International Railway Congress to the lists of questions sent out, and on other information; these reports have been for some time in the hands of members.

The reports and the descriptions of structures built on this system show that it has already been extensively used in all different branches of railway work, although it was only first introduced a comparatively short time ago; this applies not only to buildings above and below ground, but also to the many structures required in connection with the track.

The reports also show that this system of construction (given proper design and careful execution of the work) has given very excellent results, both from the

technical and from the economic point of view, and that the use of armoured concrete has long passed the experimental stage.

Concrete as such, produced by mixing cement, sand, stone and water, was already used successfully at an early period in constructing parts which were only subject to compressive stresses.

To use concrete for parts liable to bending or buckling, where not only compressive but also tensile stresses would have to be resisted, only became possible when metal was imbedded in it, such metal giving the strength necessary to resist such stresses. In this way armoured concrete came to be used.

The metal is imbedded and arranged in the concrete in many different ways; but all armouring systems can be referred to three main types, *viz.* :

1° The Monier system, in which iron netting is imbedded in the concrete;

2° The Melan system, in which girderwork is imbedded in the concrete. The girderwork does the chief work in carrying the loads; the concrete only plays a very secondary part, sometimes acting only as a covering material;

3° The Hennebique system, in which the rods used for armouring are so arranged as to resist not only the tensile stresses produced in the structure, but also the shearing stresses.

In the case of the last mentioned system, it is possible to design the structure so that all the different stresses occurring in it are provided for, and that the chief mechanical properties of concrete and of iron (resistance to compression of the former, to tension and shear of the latter) are utilized rationally and economically.

The reports submitted show that the three systems described are used by the railways belonging to the Congress; the Melan system being more generally applied in America, the Monier system in Russia and the Hennebique system in the other countries.

The statements made and the particulars given in the reports, which were drawn up independently of each other by the three reporters, agree perfectly that armoured concrete is a very suitable material for structures of all kinds.

Armoured concrete in fact combines the good qualities of stone and of iron in buildings, without having the bad qualities of either. It is as good as stone, or even better, as regards inalterability, non-conduction of heat or of sound, and fire-proof qualities; it strongly resists the action of weather, of smoke gases, and of most liquids.

In addition, owing to its great strength, it is suitable for girderwork for large spans, just as iron is; no great depth of construction being required.

The use of iron, however, gives rise to sundry difficulties from the architectural point of view, but the use of armoured concrete makes it possible to satisfy all æsthetic requirements, as concrete has the property that it can easily be given any shape required.

Moreover, the use of stone is dependent on the presence of suitable quarries,

unless indeed much time is to be lost by ordering it in advance (just like iron work) and much expense for carriage is to be incurred. On the other hand, the materials required for armoured concrete, viz. : cement, sand, broken stone, and ordinary round and flat iron, can nearly everywhere be obtained readily and quickly, without incurring heavy cost of carriage and loss of time.

Then also, stone as well as iron structures require expensive arrangements for loading and unloading, as well as for putting into place (cranes, etc.), whereas when armoured concrete is used very simple and cheap installations suffice.

The many loading tests made show that armoured concrete has the advantage, as compared with iron, of greater stiffness, i. e. of greater resistance to bending; and for this reason as well as owing to its greater mass it resists so-called dynamic actions better, i. e. the shocks and vibrations produced by rolling loads, etc.

The technical advantages mentioned naturally go hand in hand with economic advantages. The reports submitted to the Congress give particulars in this connection, which show that structures made of armoured concrete in most cases cost less to build, than they would have cost if made of other materials. Moreover, it is not to be forgotten that not only the cost of construction but also that of maintenance is an important factor. But experience everywhere has shown that the latter is very low or nil in the case of armoured concrete, whereas it is well known that structures made of iron and of wood require frequent repair, and this apart from its expense often makes it difficult or more expensive to work the traffic.

The technical and economical advantages mentioned, which armoured concrete possesses, make it sure that it has a great future before it in railway work. Henceforth its use will extend much more quickly, because the many experiments and theoretical investigations made during the last few years have resulted in obtaining the desirable scientific clearness on the subject of this system of construction. The most important results of the investigations in question, and the systems of calculation deduced from them, are described in the reports submitted by the reporters and their accuracy is estimated.

We are now in a position to calculate, by reliable methods quite sufficiently accurate for all practical purposes, the strength of armoured concrete structures, and so can determine in advance when and where this system of construction can be applied with perfect safety.

In consequence of these scientific elucidations and of the results obtained in practice, the authorities and corporate institutions of sundry countries (e. g., the Prussian Board of Works, the *Swiss Ingenieur und Architekten Verein*, the *Verein deutscher Architekten und Ingenieur Vereine*, the *German Betonbau Verein*, the American Railway Engineering and Maintenance of Way Association) have worked out detailed specifications, in which particulars are given about the properties the materials used in making concrete and in armouring it should possess, about the best way of executing such work (proportions in which the concrete is to be mixed, time required for setting, etc.), about the methods used for testing finished struc-

tures, and finally about the methods of static calculation and the greatest admissible stresses.

The particulars laid down in these specifications are not only of importance from the point of view of the building regulations, but also, because carefully and scientifically worked out by those concerned, very suitable for giving designers a good and safe basis on which to design new works and execute them, and to confirm the public confidence in the new system of construction. These specifications may safely be expected to promote the extended application of armoured concrete.

The state, thus characterized, of the question of the application of armoured concrete leads us to the following conclusions, which we herewith submit to the Railway Congress for approval :

1° Armoured concrete has been applied extensively on railways for many different purposes. It is, from the technically constructional as well as from the economic point of view, quite able to compete successfully with masonry, wood and iron work.

As this is already the case, *i. e.* after scarcely ten years of practical application of armoured concrete, it may safely be prophesied that this modern system of construction has a great future before it; all the more so as improvements and advances are being made every day.

The further application of armoured concrete is herewith strongly recommended to railway managements;

2° Of the systems of armouring hitherto applied, the Hennebique system and the analogous systems are to be preferred; they have a scientific basis and have been worked out rationally.

**The President.** (In French.) — I now call upon Mr. Tolstopiatoff to give us a summary of Mr. de Kareischa's report.

**Mr. Tolstopiatoff,** Russian State Railways. (In French.) — The use of armoured concrete in Russia for structures of all kinds dates back to about 1885. At first armoured concrete structures were built almost exclusively on the Monier system because it was the system which first received the official approval of the Ministry.

The mixture of the concrete used in the works carried out on this system, generally consisted of one part of cement to three parts of sand or gravel and exceptionally of one part of cement to four parts of sand.

The maximum stress allowed was : for concrete, 20 kilograms per square centimetre (284 lb. per square inch); for iron armouring, 700 kilograms per square centimetre (9,960 lb. per square inch).

Many trials and investigations were carried out between 1891 and 1898 at St. Petersburg and between 1898 and 1899 at Kiev, the latter by Prince Koudachev for the South Western Railway.

I need not further occupy your time in mentioning all the tests and investigations which are minutely described in the report itself.

I should, however, like to draw the attention of the section to the description given by Professor Kareischa on the very successful application of armoured concrete in constructing the caissons for bridges on the East China Railway and on the Bologoe-Sedlitz Railway.

These caissons were constructed on the pattern patented by Mr. A. N. Lentovsky. The chamber walls of these caissons are of stone masonry and the top of the chamber has a flat cover of armoured concrete.

In 1901 and 1902, Mr. A. N. Lentovsky put down sixty-two of these caissons. In going down the caissons passed through various soils such as sand, clay, rock, and conglomerate. Moreover, they were sometimes under very abnormal conditions and subjected to considerable extra stresses without any crack resulting.

The main advantages of these caissons are the following :

- 1° They cost less than those of the ordinary patterns;
- 2° They hold the compressed air without the smallest leakage;
- 3° The expenditure on metal is markedly less than that given by Mr. Brenneke for masonry caissons with arched roofs.

In comparing the cost of his caissons with that of iron caissons, Mr. Lentovsky found that one of his caissons of a sectional area similar to that of an iron one only cost from 16 to 22 per cent as much.

**The President.** (In French.) — I now have again to call upon Mr. Tolstopiatoff to read a summary of Mr. Wallace's report.

**Mr. Tolstopiatoff.** (In French.) — The general use of Portland cement concrete for permanent way constructions in America hardly dates back further than 1894 and 1895. The main reasons that led to the present generalisation of the use of Portland cement, are : 1° the lack of generally distributed good dimension stone, easily cut and worked ; 2° the growth of the Portland cement industry (the consumption of cement in the States in 1902 was 28,627,429 barrels [5,152,937,220 kilograms], the extreme prices at the mill being 90 cents to 2 dollars 50 cents per barrel [2.50 to 6.95 francs per 100 kilograms]); 3° the facility with which concrete can be handled, as compared with dimension stone, and the decreased car equipment required, and 4° the difference in cost between Portland cement and dimension stone.

Some very interesting experiments and theoretical investigations have been undertaken by Professor W. K. Hatt, of the Purdue University, at Lafayette (Indiana) with a view to discovering a good method of analyzing the strength of armoured concrete under flexure.

The theory takes account of that part of the bending moment due to tensional forces in the concrete, and it supposes that the stress in the concrete of the beam varies with the distance from the neutral axis.

The tests were conducted on beams  $8 \times 8$  inches in cross-section of 1-2-4 concrete.

The main facts disclosed by these tests are the following :

1° The flexibility of reinforced concrete beams, that is, the degree of deflection before cracks, visible to the naked eye, are formed in the lower part of the beam, is about ten times that of a beam without reinforcement;

2° In the tests of this 1-2-4 concrete, the first visible failure was a tension crack in the concrete at the centre of the beam. The tensile strength of the concrete in the 1-2-4 beams was about 300 lb. per square inch. After the first visible crack in tension it spreads upwards. There the strength of the steel in tension and concrete in compression is brought into play. The higher the elastic limit of the steel, the more one postpones the point of rapid increase in the width of this crack, and when steel is used of sufficiently high elastic limit, and in sufficient quantity, the compression strength of the concrete in the upper flanges will be developed;

3° On examining the diagram of the deflections observed in reinforced concrete beams, it is easy to see that the ratio between the load and deflection remains very nearly constant up to the point " A ", which is one half to one third the maximum strength. The inclination of the curve then becomes less to the deflection axis, and the deflection proceeds until a crack visible to the naked eye appears in the tension flange of the beam, accompanied by a deflection of about one five hundredth part of the span.

Professor Hatt has advanced a theory to account for these three points : " A ", first crack and maximum strength, and finds his theory is flexible enough to predict the behaviour of a beam at various stages of the test, when such beam is reinforced with different percentages of metal placed at different parts of the cross-section.

The equations supplied by this theory are complicated and difficult to apply, but they can be represented graphically or replaced by a simple formula that may be called " The straight line formula for a reinforced concrete beam " and it, for ordinary percentages of reinforcement, meets all requirements.

Very important tests were also carried out by Messrs. Samuel W. Emerson and George A. Peabody; they had for their object the determination of the existence and the amount of the initial stress in imbedded steel rods due to the expansion and contraction of concrete.

After investigating the results obtained by the tests mentioned and by other tests of less importance, the author came to the conclusion that further experiments upon the fatigue of reinforced beams and the variations caused by using different grades and proportions of material are needed before steel concrete structures can be designed with the same accuracy as in steel structures. For the present, the author of the report, Mr. Wallace, believes it advisable to observe the following precautions :

1° The factor of safety should be chosen both with reference to the elastic limit of the steel reinforcement and with reference to the point " A " of the Hatt formula,

which is approximately the point at which the tension strength of plain concrete is exceeded;

2° Where the structure is to be subjected to an indefinite number of repetitions of stress, the greatest possible stress including temperature and contraction stresses, and a reasonable allowance for impact, should not exceed the limit of the point "A" in Hatt formula, with a reasonable factor of safety, say one and one half.

The additional strength corresponding to the elastic limit of the steel can be considered as an additional safety factor;

3° In all structures, the shearing stresses should be carefully considered;

4° An efficient anchorage should be provided at the ends of all reinforced beams;

5° During and after construction, all concrete should be well sprinkled in order to avoid, as few as possible, the contraction stresses;

6° Concrete laid in air should generally be reinforced with steel to prevent shrinkage and temperature cracks and to add tensional strength and flexibility.

Mr. Wallace's report then goes on to give a detailed description of various extremely interesting structures of reinforced concrete carried out by American railways.

In closing this summary, I will content myself with drawing your attention to the fact that of eighty-eight American railways that have sent in replies to the author, representing a total mileage of 115,000 miles, thirty-nine railways with a mileage of 79,112 miles generally use concrete structures in road-bed structures, and four roads with a mileage of 11,749 miles use reinforced concrete in road-bed structures where concrete alone is not of sufficient strength to carry the load.

Mr. Wallace's report does not contain any general conclusions, but it in no way contradicts the conclusions proposed by the other reporters.

**The President.** (In French.) — The first of the conclusions submitted to the sections by Messrs. Kupka and Tolstopiatoff and now to be discussed, reads as follows :

" 1° Reinforced concrete has received many and important applications on railroads. Both from the technical and economical point of view, it can fully and successfully compete with masonry and timber or steel construction. "

**Mr. Müntz,** French Eastern Railway. (In French.) — For my part, I have no positive data as to the good preservation of armoured concrete works underneath tracks. As regards those above the soil, I do not for a moment question the value of armoured concrete.

**Mr. Bauchal,** French Western Railway. (In French.) — The Western Company of France finds that structures spanning 6, 8 and 10 metres (19 ft. 8 <sup>1</sup>/<sub>4</sub> in., 26 ft. 3 in. and 32 ft. 9 in.) can very well be made of armoured concrete.

My personal experience has led me to recognize that we ought to draw a distinction between armoured concrete put in before a line is opened and that which is laid once a line has been opened.

We wanted to strengthen some iron structures on a double line which was being worked, using armoured concrete and we found that the execution of the work presented several disadvantages. First of all, the process prolongs, often to an intolerable degree, the time occupied in repairs, because on each track one has to wait till the concrete is set.

Secondly, it is not certain whether the vibrations caused by trains running on one of the tracks are not likely to interfere with the proper setting of the concrete used on the other track and with the proper adhesion of this concrete to its metallic bed.

**Mr. Elskes, principal secretary.** (In French.) — I should like to recount to you some experiments I had an opportunity of making myself.

In a Vienna paper, I had occasion to mention the result of some experiments carried out on the Jura-Simplon railways in Switzerland which now form part of the Federal system. (*Mr. Elskes handed round some plates from this journal "Beton und Eisen", 1903.*)

Since 1894, I have constructed a certain number of armoured concrete bridges of which spans did not exceed 4.80 metres (15 ft. 9 in.); they all consisted of floor slabs and parallel girders which had no thrust on the abutments.

I share Mr. Bauchal's opinion in thinking that the spans of these bridges ought not to exceed 8 or 10 metres (26 ft. 3 in. or 32 ft. 9 in.).

As for the difficulty of working on lines in operation, I think a large measure of compensation for the trouble caused will be found in the advantages arising from the use of armoured concrete.

During the ten years since the bridges I mentioned were built, expenditure on their maintenance has been practically *nil* as compared with the expense of maintaining iron bridges.

I think, however, that it would be wise for the Congress not to express any views yet with regard to bridges to be constructed under the track, because experience in this direction has been too small.

It is to be hoped that during this discussion we may hear the views of some specialists, especially of Mr. Rabut who is an authority on the subject. He has had a large experience of this process, and will be able to give us valuable information.

As Mr. Rabut is not present, I hope you will adjourn the discussion on conclusion I until to morrow.

**The President.** (In French.) — As the subject of armoured concrete was not to come up for discussion until to morrow morning, Mr. Rabut has every excuse for not being present this afternoon.

As suggested by Mr. Elskes, it would be of great interest to the section to hear what this French engineer has to say and consequently I think you will all agree that it would be well to adjourn our debate till to morrow. (*Agreed.*)

— The meeting rose at 2-30 p. m.

---

**Meeting held on May 11, 1905 (morning).**

---

— The first conclusion, the text of which was read at yesterday's meeting, was put to the vote and adopted.

**The President.** (In French.) — The second conclusion proposed by Messrs. Kupka and Tolstopiatoff reads as follows :

“ 2° Tests of reinforced concrete structures, theoretical researches on the question, and the results of practice justify the conclusion that such structures need not cause any apprehension, and that their application be strongly recommended to railway administrations. ”

— This conclusion was adopted.

**The President.** (In French.) — The third conclusion suggested is as follows :

“ 3° Railroad practice shows that carefully built reinforced concrete structures give excellent service and require almost no maintenance. For this reason the use of reinforced concrete should be recommended. ”

**Mr. Elskes, principal secretary.** (In French.) — After yesterday's meeting I had an interesting discussion with Mr. Bauchal, who you will remember made some objections as regards the cost of armoured concrete.

I should like to say that our experience in Switzerland proves that, allowing for the inconveniences arising on lines in operation, the cost of armoured concrete bridges is perhaps higher than that of iron bridges, although in itself armoured concrete is cheaper than iron. But despite this increased cost of construction, there are still very serious economic advantages in using reinforced concrete, and these advantages result as I have stated, in a marked reduction in maintenance expenses.

I may add that the bridges which have been built in Switzerland are not only on secondary lines but also on main lines, for instance, on the line between Lausanne and Geneva and on the Simplon.

Not only has the Swiss Federal Inspecting Department made no objection to the construction of such works, but it has actually encouraged experiments with armoured concrete.

**Mr. Rabut, French Western Railway.** (In French.) — I think, gentlemen, it would

be too sweeping to assert that, though it involves difficulties in working, armoured concrete is not as cheap as metal.

If we were to interpret Mr. Bauchal's observation in this sense, we should be going too far. I can give you an instance of the use of armoured concrete on a line where there are extraordinary difficulties in operation, and yet armoured concrete proved advantageous, not only from an economic point of view, but also from the standpoint of the speed at which it was carried out as compared with putting in metal.

I am alluding to the quadruple line from Paris to Auteuil, between Courcelles and the Paris Champ de Mars station. The work was begun in 1898 and finished in 1900 for the Exhibition.

We had to put in four tracks for 3 kilometres (1·86 mile) and that was inside Paris at the bottom of a cutting 6 metres (19 ft. 8 in.) deep lined with sustaining walls. On the two existing lines trains were running both night and day at intervals of every five minutes. There are, on this line, twelve bridges and tunnels over which pass roads with heavy traffic such as the Avenue de la Grande Armée and that of the Bois de Boulogne — traffic that could not be interrupted.

The work was therefore surrounded with exceptional difficulties especially in view of the lack of room for putting up sheds.

First we had to build new sustaining walls, pull down and rebuild the bridges and tunnels which spanned the line; we had to construct projections extending as much as 3 metres (9 ft. 10 in.) to carry the two boulevards which run along the line. Well, all this work was carried out almost exclusively in armoured concrete, and the Western Company found that if it had employed iron work, the cost would have been twice as much and, moreover, that the job could not have been finished in time for the opening of the Exhibition.

The saving in cost with armoured concrete is largely due to the ease with which the materials can be conveyed to the spot where it is wanted; this requires only wheelbarrows and hand labour, whereas iron girders necessitate the use of special machinery to convey and lift them.

**Mr. Elskes.** (In French.) — The remarks I made were in no wise intended to demand an alteration in the wording of the conclusion, but simply to dissipate a misunderstanding that might have arisen from Mr. Bauchal's assertion. I should like to make it clear that it is only exceptional for the cost of certain bridges in armoured concrete to be higher than the cost of iron work.

**The President.** (In French.) — From Mr. Elskes's explanations we may gather that the third conclusion as worded might be understood to mean that the cost of armoured concrete was higher than that of iron work. After having heard Mr. Rabut's statement, Mr. Elskes has no objection to the conclusion being adopted.

But in order to do away with any possible misconception, I should like to ask whether it would not be well to add the words : " Even if the cost of construction should, exceptionally, be higher than for another system of construction. "

**Mr. Bruneel, principal secretary.** (In French.) — I may point out that the contradiction between the statements of Messrs. Elskes and Rabut is more apparent than real.

For, the works, designs of which Mr. Elskes has shown to the section, are all under the track, whereas those mentioned by Mr. Rabut are overhead.

The difficulties in working in armoured concrete are incomparably greater when one comes to deal with work underneath a railway and hence the increased expenditure alluded to by Mr. Elskes for bridges of armoured concrete. I think I am, in this respect, at one with Mr. Rabut.

**Mr. Rabut.** (In French.) — Quite so.

**Mr. Bruneel.** (In French.) — Under these circumstances I support the conclusion as amended by the President.

— The third conclusion was put to the vote and adopted as follows :

“ 3° Railroad practice shows that carefully built reinforced concrete structures give excellent results and hardly require any maintenance. For this reason, the use of reinforced concrete should be recommended, even if the cost of construction should, exceptionally, be higher than for another system of construction. ”

**The President.** (In French.) — The fourth conclusion suggested runs as follows :

“ 4° Reinforced concrete structures are especially useful in countries where building materials, such as stone and iron, are difficult to obtain in large sizes. ”

**Mr. Elskes, principal secretary.** (In French.) — I should like to ask American engineers a question. Is it true that in America, armoured concrete is used for structures intended not only to carry loads, but also to take the place of split dimension stone? In Switzerland this has been tried; armoured concrete has been used to cap the piers of viaducts. To fashion blocks of armoured concrete on the spot is unquestionably cheaper than lifting heavy stone at great expense to the top of these piers.

In these blocks, the metal is intended mainly to hold the monolith better together. I should very much like to hear what our American colleagues have to say on the results of any experience they have on this subject.

**The President.** (In French.) — Some members of the section have erected large structures of armoured concrete, and I hope they will supply the information demanded by Mr. Elskes.

**Mr. Elskes.** (In French.) — It was a retired engineer on the Northern Pacific, now a Zurich professor, who told me that the procedure I mentioned was followed in America.

As regards Switzerland, I may say that the applications made have been crowned

with success; the blocks obtained are extremely hard and stand the weather perfectly.

**Mr. Jégou d'Herbeline**, Orleans Railway, France. (In French.) — The armouring is only intended to make the concrete more monolithic, for in itself it is as hard as most natural stone.

**Mr. Elskes**. (In French.) — In raising the question, I had no other intention than to point out that armoured concrete can quite well be used in place of stone.

**Mr. Jégou d'Herbeline**. (In French.) — It must not be supposed from what **Mr. Elskes** has just said that all iron bridges should be replaced by bridges of armoured concrete, but that in countries where iron is expensive armoured concrete may without inconvenience be used for constructions in place of iron.

**Mr. Rabut**. (In French.) — The main characteristic of reinforced concrete is the diversity of the methods in which it can be used.

Sometimes it is used on the spot by surrounding iron with concrete, sometimes concrete is prepared at the works and delivered in blocks, which are especially suitable for floor work. Edgings for quays are made of artificial stone and they cost less than similar ones in granite. The blocks mentioned by **Mr. Elskes** come under this heading.

**The President**. (In French.) — I am glad to find that American engineers deriving their inspiration from what has been done in Europe, have helped to extend the use of concrete to take the place of stone work that has to be lifted in buildings.

— The fourth conclusion was adopted.

**The President**. (In French.) — The fifth conclusion runs as follows :

“ 5° Reinforced concrete makes it possible to execute works quickly with materials readily obtainable and this avoids the necessity of giving special orders to shops, which is often a troublesome matter in practice. ”

**Mr. Jégou d'Herbeline**. (In French.) — I should like to say a word about a larger undertaking we have just finished on the Orleans Railway between Paris and Juvisy. We used armoured concrete extensively in building overhead bridges instead of level crossings.

Some of these bridges were finished and ready for use within two months from the day the plans were approved. However, we did not get clear of the job until a little later. If these same bridges had been built of iron, allowing for the preliminary work at the shops, they would have taken double the time.

So now concrete makes it possible to carry out work rapidly and mainly thanks to its being feasible to begin the work the very day after the plans have been completed.

— The conclusion was adopted.

**The President.** (In French.) — The sixth proposed conclusion reads as follows :

“ 6° Of the systems of reinforcing hitherto tried, preference should be given to the Hennebique system and to the other systems based on the same principles, which the scientific study of reinforced concrete has fully justified. ”

**Mr. Maas-Geesteranus**, Dutch Railways, Holland. (In French.) — I request that Mr. Hennebique's name be omitted from this conclusion. The Congress has always held that in its resolutions nothing that may be regarded as a business advertisement should be allowed to appear.

And then a good reason in my opinion for refusing to mention the Hennebique system is that the reporter, Mr. Ast, declares that the method of calculation employed by Mr. Hennebique is empirical. It is, therefore, difficult to harmonize this criticism with the end of the conclusion which implies that the Hennebique system is based on scientific principles.

**Mr. Rabut.** (In French.) — The conclusion raises two questions. First, whether we can mention by name a firm that manufactures armoured concrete. Secondly, whether the process used by this firm is scientific or not.

As regards the first point, I think we shall all agree that, as a rule, the Congress ought not to mention one firm rather than another. But it should be remarked that Mr. Hennebique is not only a business man but a great inventor; if he did not discover armoured concrete, it cannot be denied that he is the man of business who has done most to extend its use.

This is why Mr. Ast, who knows how to estimate the value of the phrases he uses, has thought it just to name Mr. Hennebique in his paper.

I therefore think that Mr. Hennebique's name might be retained in the text of the conclusion, provided it is drawn up in such a way that it does not assume the slightest aspect of a business advertisement.

Mr. Ast would seem to have chosen a suitable formula when he says “ the Hennebique system and other systems based on the same principles ”. Of such other systems, there are plenty. Many builders, especially in France, have taken out patents for variations of the Hennebique system, variations which differ only in detail, the principle being in reality the same.

Personally, I feel that by saying “ the Hennebique system and the other systems based on the same principles ” we cannot be accused of manufacturing a business advertisement; we are simply deciding upon a group of building suggestions.

Mr. Hennebique has no pretension to being a scientist, but we cannot refuse him the honour of having, to some extent, determined the hard and fast rules concerning armoured concrete, and of having used it frequently with the best results.

His system has been studied by scientific men — I may mention more particularly Mr. Considère, inspector-general of roads and bridges of France — who have found that its characteristics conform to reasonable and scientific principles.

**Mr. Maas-Geesteranus.** (In French.) — If I am not mistaken many works in armoured concrete were executed in Russia even before the Hennebique system was applied in France.

I persist in my view that it would be better to avoid mentioning any name in the conclusion so that we cannot be accused of advertising. If any name ought to be mentioned it is not that of Mr. Hennebique because there were people before him in the field.

I have no desire to deprive Mr. Hennebique of any honour he may deserve. I fully realize that he has built remarkable works which have behaved very well, but I cannot accept a statement to the effect that the Hennebique system is based on scientific principles when Mr. Ast himself has stated that the system is empirical.

**Mr. Elskes.** (In French.) — Like Mr. Maas-Geesteranus I felt that the conclusion suggested by Mr. Ast was a little too categorical and that is why the reporters thought it their duty to modify it.

The new wording by no means states that Mr. Hennebique was the first to use armoured concrete; nor does it state that Mr. Hennebique has carried out a large number of works. It states that practically his system and those which are based on similar principles are the best. This view is held by all who have used armoured concrete.

Without any wish to hurt the feelings of our Russian colleagues, I feel bound to say that the list of works carried out in Russia with armoured concrete is meagre, and that if one wanted to draw a comparison between the countries who first used armoured concrete, Russia would not come first but Switzerland, provided, of course, we consider railways only as is our business.

I therefore support Mr. Rabut's opinion and I propose to the section that we word the conclusion as follows :

“ Amongst the systems of armouring used up to the present, the best are the Hennebique system and those which resemble it. Scientific research and the improvements made make it possible to build in a reasonable manner. ”

**Mr. Jégou d'Herbeline.** (In French.) — I think we ought to divide this conclusion in voting, that is to say, give a definite opinion on the question of whether empirical methods ought to give place to scientific procedure.

We ought not to lose sight of the fact that reinforced cement was invented by builders and not by men devoted to pure science. But there is a tendency for scientists to interfere perhaps a little too much, at least in France, and this is a pity because their intervention will inevitably result in putting up the cost of armoured concrete until it becomes as high as metal.

As we know, steel bridges have suffered much from over-regulation. Thanks to it the weight of steel for bridges has become excessive and Government edicts will bring about the same result in the case of armoured concrete.

That all the works in armoured concrete have stood the tests to which they have been subjected perfectly is unquestioned and this is what we ought to assert. After passing the first portion of the conclusion we ought, I think, to express in the second part a hope that pure science will not interfere too much in the methods of making armoured concrete.

**Mr. Rabut.** (In French.) — I agree in thinking that it would be well to subdivide the conclusion because it contains two quite separate ideas.

**Mr. Elskes.** (In French.) — Could we not make two conclusions?

**Mr. Bruneel.** (In French.) — I agree with those of my colleagues who have given due credit to Mr. Hennebique; like them I feel that he has carried out remarkable undertakings in armoured concrete. But Mr. Hennebique did not invent the process. He is one of those who have done most to propagate its use.

I think however that we ought to show great prudence and avoid, as has just been suggested, passing a clause which would seem like an advertisement. It has been my privilege to attend the meetings of the Railway Congress ever since its foundation and it has always been accepted as a wise policy to allow no reference to a name or a process which might be regarded by those who took no part in our labours as a business advertisement.

This explains why I suggest to you that we should simply eliminate this sixth conclusion. The remarks that have been exchanged will suffice to instruct all those who take an interest in the subject. The conclusion before us adds nothing bearing upon the data supplied.

Without underrating Mr. Hennebique's ability I think that there are other men to whom one might equally well entrust important works in armoured concrete.

**The President.** (In French.) — We now have before us a proposal to strike out the sixth conclusion.

I may say that the elimination of this conclusion would in no way detract from the value of those which precede it and they clearly express the views of the section in so far as the advantages offered by armoured concrete are concerned.

**Mr. Rabut.** (In French.) — I do not think there would be any serious inconvenience in the matter if we look at the subject from a practical and technical standpoint and say "the Hennebique process and analogous processes".

I may mention, as applying to France, the Coignet, Boussiron, Piketty, Brault and Lhermite, Boulanger and Schüttl systems, etc., etc.

All these builders use practically the same rules as Mr. Hennebique.

What are the reasonable principles upon which the Hennebique system depends?

The idea is to make the metal withstand all the tensile stresses; when iron in compression is used, allowance must be made for the differences in compressibility of the concrete and of the metal and finally to withstand shearing strains special secondary parts have to be added to the main armourings.

What harm can it do if the Congress approves a thing that has been recognized as good? I consider, on the contrary, that it would be a good thing to confirm these principles, while taking care to word our conclusion so that there should be no suspicion of a business advertisement about it.

**Mr. D. W. Lum**, Southern Railway, United States. — Mr. President, there are several companies doing business and using several systems in this country, among which are the Kahn, Thatcher, Ferro-Concrete and Hennebique, and it seems to me that it would be rather an injustice to those other parties who represent other systems that have been successful, if we mention only the Hennebique and make no reference to their systems which have been successful.

**Mr. G. W. Kittredge**, Cleveland, Cincinnati, Chicago & St. Louis Railway. — I want to urge the suppression of the conclusion altogether, not especially because of the wording, though personally I favor the omission of any reference to individual names. The conclusion ought to be suppressed now, in order that we may get on to the discussion of something more valuable. It seems to me the discussion has proceeded entirely too long on this line.

**The President.** — It is now proposed to vote the suppression of this sixth conclusion. Those who are against the suppression of this conclusion are invited to hold up their hands.

**Mr. R. Trimble**, Pennsylvania Lines West of Pittsburgh. — Mr. President, I rise to a point of order. In a conversation with Mr. Kruttschnitt, he told me that there was something in the blue book which we have for our guidance which prevents this body from taking a vote on any subject. We are here to discuss matters, but we do not vote on these matters, and the results are determined from the discussions and not from votes.

**Mr. Bruneel**, *principal secretary* (In French.) — I have been present at nearly all the previous conferences, and I can say that it is always customary to vote on the conclusions, either formally by calling for a show of hands, or by the president simply calling upon members who are against a resolution.

**The President.** — I consider, taking note of what has passed in former conferences, that I was in order in putting this question to a vote. However, there seems to be a difference of opinion on that point, and I consider that the question would be settled if the committee who drew up these conclusions would simply withdraw conclusion No. 6.

**Mr. Tolstopiatoff.** — I do not insist.

**Mr. Kupka.** — Nor I either.

**The President.** — Conclusion No. 6 having been withdrawn by its authors, the question is now settled and satisfaction has been given to Mr. Trimble who opposed

the question of voting on this point. I should, nevertheless, like to call Mr. Trimble's attention to the fact that the other sections have voted on some points and I think that I was in order in having put this question to a vote.

Gentlemen, the labours of the first section are concluded.

I think I shall be interpreting your wishes if I suggest that we should convey our best thanks to our President, who has been called away to New York by urgent business, for the manner in which he presided over the earlier meetings of the section. (*Applause.*)

For my part, gentlemen, I beg to thank you for the indulgence you have displayed towards me, for it has greatly facilitated my task in directing the course of your labours, — a task for which I was by no means prepared.

I congratulate you on the zeal which you have shown and on the scientific manner in which the debates have been conducted.

**Mr. Elske.** (In French.) — I know, gentlemen, that it is with applause that you will receive my proposal to thank Mr. Pontzen most heartily for the splendid way in which he has fulfilled his duties as President. He has just told us that he was not prepared for the task; he has, however, performed it with ability and discretion skilfulness. I wonder what sort of a President he would have made if he had had time to prepare himself for it! Thanks to him we are among the first to finish our labours. (*Prolonged applause.*)

— The meeting then rose.

## DISCUSSION AT THE GENERAL MEETING

---

Meeting held on May 13, 1905 (afternoon).

---

MR. STUYVESANT FISH, PRESIDENT, IN THE CHAIR.

GENERAL SECRETARY : MR. L. WEISSENBRUCH.

ASSOCIATE GENERAL SECRETARY : MR. W. F. ALLEN.

The President reads the :

### Report of the 1<sup>st</sup> section.

(See the *Daily Journal of the session*, No. 9, p. 186.)

“ Vice-president PONTZEN announced that in the absence of Messrs. de Kareischa and Ast who were detained in Europe, Messrs. Kupka (*Nord Empereur-Ferdinand, Austria*) and Tolstopiatoff (*Russian State Railways*) had jointly agreed (not being able to meet Mr. J. F. Wallace) to draw up a draft of conclusions based on the three reports presented.

“ Mr. TOLSTOPIATOFF gave first an analysis of the reports by Messrs. de Kareischa and J. F. Wallace. Mr. de Kareischa's report states that reinforced concrete on the Monier system was used in Russia since 1885. One of the most recent examples is the construction of the caissons for the piers of the bridges on the Transmanchurian and Bologœ-Sedlitz railways.

“ Mr. J. F. Wallace's report gives statistics showing the growth of the manufacture of cement in the United States; he describes the different methods used, and gives numerous illustrations of applications made. This report does not draw any conclusions, but in all its parts it is in perfect accord with those of the other reporters.

“ The conclusions proposed jointly by Messrs. Kupka and Tolstopiatoff were then read. The first conclusion read was as follows :

“ 1<sup>o</sup> Reinforced concrete has received many and important applications on rail-

roads. Both from the technical and economical points of view, it can fully and successfully compete with masonry and timber or steel construction. ”

“ Mr. MÜNTZ (*French Eastern Railway*) remarked that there are no positive data as to the good preservation of structures built for railroads.

“ Mr. BAUCHAL (*French Western Railway*) stated that the experience acquired to the present time has demonstrated the possibility of building such structures for small spans, 8 or 10 metres (26 to 33 feet), at the most. As to structures built under railroads in operation, reinforced concrete presents the difficulty of often extending the time of construction to an excessive extent. He was not certain whether the vibrations caused by the trains running on one of the tracks, were not of a nature to endanger the perfect hardening of the concrete on the other track, as well as the adhesion of the metal to the concrete.

“ Mr. ELSKES (*Swiss Federal Railway*) reported on experiments which he had made himself. He published, two years ago, information on small bridges built since 1894 by the Jura-Simplon Company in Switzerland; the span of the most important of these structures was 4.80 metres (15 ft. 9 in.); they all consist of floor slabs and parallel girders. Mr. Elskes agreed with Mr. Bauchal’s opinion that spans of 8 to 10 metres (26 to 33 feet) at most should not be exceeded for such structures, when built to carry railroad tracks.

“ If the erection of reinforced concrete structures under lines in operation causes difficulties during erection and costly delays, the important advantages presented by these structures in the matter of maintenance should also be considered. Mr. Elskes thought, however, that the experiments made up to the present time, are as yet too few in number and have been made on too small a scale to induce the Congress to recommend reinforced concrete bridges under railroad tracks unreservedly, which, by the way, has not been done in the proposed conclusions. He thought that it would prove useful to the section to first hear some specialists on this subject, notably Mr. Rabut, who is an authority on this question, because of the structures built, and the many and interesting investigations which he has made.

“ The first conclusion was adopted, as well as the following second conclusion :

“ 2<sup>o</sup> Tests of reinforced concrete structures, theoretical researches on the question, and the results of practice justify the conclusion that such structures need not cause any apprehension, and that their application be strongly recommended to railway administrations. ”

“ Mr. TOLSTOPIATOFF then read the third of the proposed conclusions.

“ Mr. ELSKES stated that experience in Switzerland has shown that, because of the limitations encountered on lines in operation, the cost of reinforced concrete bridges may be higher than that of metal bridges, though reinforced concrete itself

may be cheaper than metal; but in this case there is still an economic advantage, if the cost of maintenance is taken into account.

“ Mr. RABUT (*French Western Railway*) thought it would be too general to state that reinforced concrete is not more economical in first cost than metal, even if there be limitations due to the operation of the line. He mentioned the work of double tracking of the Paris belt line, in order to establish a new connecting line between Courcelles and Champ-de-Mars. This work presented very serious difficulties in construction, which were chiefly due to choosing points at which to locate the workshops. The greater part of the work was done in reinforced concrete, and it has been admitted that to build the same work in metal would have cost more than in reinforced concrete. The smaller cost is mainly due to the ease of laying reinforced concrete, which requires the use of wheelbarrows only, while metal beams are difficult to handle and require special hoisting engines. The work was, besides, done in incomparably less time than would have been required if metal had been used.

“ Mr. BRUNEEL (*Belgian State Railways*) stated that the difference in opinions of Messrs. Elskes and Rabut was more apparent than real. The structures, the plans and sections of which have been transmitted to the section by Mr. Elkes, are all structures carrying tracks, while the structures cited by Mr. Rabut are all overhead structures. The difficulties are incomparably greater for a structure intended to carry tracks in operation; it is, therefore, natural that the effect of these difficulties should also be incomparably greater than for overhead structures. He, therefore, supported the conclusion proposed by the reporters, reserving to himself the introduction of a change in detail.

“ The conclusions were adopted as follows :

“ 3° Railroad practice shows that carefully built reinforced concrete structures give excellent results and hardly require any maintenance. For this reason, the use of reinforced concrete should be recommended, even if the cost of construction should, exceptionally, be higher than for another system of construction. ”

“ The fourth conclusion is as follows :

“ 4° Reinforced concrete structures are especially useful in countries where building materials, such as stone and iron, are difficult to obtain in large sizes. ”

“ Mr. ELSKES took the opportunity of asking his American colleagues whether, as he had been told, they use reinforced concrete not only for beams, but also for building blocks, and if so, what results have been obtained so far with the latter. In Switzerland, special applications were made, mainly for pedestal stones for high viaduct piers, where it was much more economical and easier to make a reinforced concrete block in place than to lift heavy stones to the tops of the piers at a great

expense. In these applications, the imbedded metal is mainly intended to tie the block more together.

“ Mr. RABUT declared that the uses of reinforced concrete are extremely varied and that the blocks mentioned are one of the innumerable applications of reinforced concrete in special cases.

— “ The fourth conclusion was then adopted.

“ The fifth conclusion was proposed as follows :

“ 5° Reinforced concrete makes it possible to execute works quickly with materials readily obtainable and this avoids the necessity of giving special orders to shops, which is often a troublesome matter in practice. ”

“ Mr. JÉGOU D'HERBELINE (*Orleans Railway*) called the attention of the section to the work done by the Orleans Railway Company in double tracking its line from Paris to Juvisy. Especially many overhead bridges were built. These were erected in two months from the day of the final approval of the plans to the day of putting them into service. Building these bridges of metal would have taken almost double the time, including the preliminary work at the shops. Concrete thus permits of rapid construction because the work of construction can be started the very day after the plans have been approved.

— “ The fifth conclusion was adopted.

“ The sixth conclusion proposed read as follows :

“ 6° Of the systems of reinforcing hitherto tried, preference should be given to the Hennebique system and to the other systems based on the same principles, which the scientific study of reinforced concrete has fully justified. ”

“ Mr. MAAS-GEESTERANUS (*Holland Railway*) proposed omitting the name of Mr. Hennebique from the conclusion. It appeared all the more inadmissible to connect this name with the word “ scientific, ” which appears in the conclusion, as the reporter himself had found Mr. Hennebique's method of calculation to be purely empirical.

“ Mr. RABUT expressed his entire agreement with Mr. Maas-Geesteranus regarding the necessity of avoiding even the appearance of advertising any system; still Mr. Hennebique is not only a business man but a man of considerable merit, who, if he did not invent reinforced concrete, has at least introduced it to the greatest extent and made some extremely important applications. It was after very thorough investigation that Mr. Ast was led to cite Mr. Hennebique's name in his own conclusions, and by taking this name with the necessary and reasonable restrictions, it would appear that it might be retained in the conclusions. Mr. Hennebique's system, while originally empirical, has for a long time been adapted by various engineers to scientific methods of calculation.

“ Mr. MAAS-GEESTERANUS was unable to share this opinion and sustained his motion.

“ Mr. ELSKES was under the same impression as Mr. Maas-Geesteranus, that the conclusion proposed by Mr. Ast was too sweeping, and he had observed with satisfaction that the reporters had already modified it to some extent. He shared, however, the point of view of Chief Engineer Rabut, and proposed to the section a still more qualified wording.

“ Mr. JÉGOU D'HERBELINE proposed to subdivide the conclusion and reserve the second paragraph relative to the scientific character of the calculations. There is a tendency in France to lay too much stress on scientific investigation, which leads to imposing more and more severe requirements, which will end in making reinforced concrete more costly than metal. He thought it undesirable to dwell too much on the necessity of prolonging this scientific investigation. The present processes of computation have permitted the construction of works which have given very remarkable results, although these processes, even now, are sometimes stigmatized as empirical.

“ Mr. BRUNEEL shared the opinion expressed by several members regarding the merit of Mr. Hennebique's work; he joined in the approval that had been expressed, but, recalling previous labors of the Congress, he pointed out the prudence with which it had carefully avoided quoting, in conclusions, any name or any process which these might seem to advertise. He insisted on the necessity of suppressing such names, and under these circumstances the only course left to the section is to strike out the entire conclusion. The statements which have been made during the discussion are sufficient for purposes of general information, and every one can gather useful information from them. The conclusion proposed, does not add anything to this information.

“ The VICE-PRESIDENT remarked that Mr. Bruneel's proposal to strike out does not affect the importance of the preceding conclusions, in which the section expresses, in very definite terms, its very favorable opinion of applications of reinforced concrete.

“ Mr. RABUT insisted that he could see no objection to mentioning the Hennebique process, in company with similar processes which follow similar rules in the method of computation and mode of stressing the members. These processes, in their present stage of development, have assumed a true scientific character.

“ Two American delegates, Messrs. D. W. LUM (*Southern Railway*) and G. W. KITTREDGE (*Cleveland, Cincinnati, Chicago & St. Louis Railway*), stated that the Hennebique system and many other systems have been applied in America, and that it seemed to them impossible, without committing an injustice, to quote

Mr. Hennebique's name alone, and leave out the names of the other systems. It was their opinion that the conclusion could and should be omitted.

" Messrs. KUPKA and TOLSTOPIATOFF being in favor of omitting the conclusion, it was abandoned.

" The VICE-PRESIDENT, finding that the section had concluded its work, moved, firstly, to thank President Kruttschnitt for the energy and courtesy with which he had directed the labors of the first meetings. He also thanked the meeting for their intelligent cooperation, and congratulated the members on the zeal and scientific spirit which they had brought to this work.

" Mr. ELSKES seconded this motion and thanked Vice-President Pontzen, in the name of the section, for the ability with which he had conducted and stimulated the debates.

" The section finally adopted the following resolutions for submission to the general meeting. "

**The President.** — The following are the

#### CONCLUSIONS.

" 1° Reinforced concrete has received many and important applications on rail-roads. Both from the technical and economical points of view, it can fully and successfully compete with masonry and timber or steel construction.

" 2° Tests of reinforced concrete structures, theoretical researches on the question, and the results of practice justify the conclusion that such structures need not cause any apprehension, and that their application be [[strongly]] <sup>(1)</sup> recommended to railway administrations.

" 3° Railroad practice shows that carefully built reinforced concrete structures give excellent results and hardly require any maintenance. For this reason, the use of reinforced concrete should be recommended, even if the cost of construction should, exceptionally, be higher than for another system of construction.

" 4° Reinforced concrete structures are especially useful in countries where building materials, such as stone and iron, are difficult to obtain in large sizes.

" 5° Reinforced concrete makes it possible to execute works quickly with materials readily obtainable, and this avoids the necessity of giving special orders to shops, which is often a troublesome matter in practice. "

**The President.** — Is there any objection ?

**Mr. von Leber**, Imperial and Royal Austrian Railway Ministry. (In French.) — The English text does not conform exactly with the French. In the latter, there

---

(1) This word was omitted in the final draft (*vide* the discussion hereafter).

appears in the second conclusion the word “ instamment ” (strongly) which is not given in the English. I propose that it be struck out.

**The General Secretary.** (In French.) — The president of the section agrees to striking out the word “ instamment ” from the second paragraph of the French text.

**The President.** — Does any one object to the word being eliminated? If not the second paragraph is adopted with this alteration.

— The whole of the conclusions with this one alteration was then put to the vote and adopted.

---

2<sup>nd</sup> SECTION. — LOCOMOTIVES AND ROLLING STOCK.

---

[ 621 .154 ]

QUESTION V.

---

LOCOMOTIVES OF GREAT POWER

---

*Increase in the power of locomotives by the adoption of high pressures and of the compound principle. Improvements in construction from this point of view. Use of nickel steel.*

*Reporters :*

*America.* — Mr. J. E. MUHLFELD, general superintendent of motive power, Baltimore & Ohio Railroad.

*Other countries.* — Mr. Édouard SAUVAGE, ingénieur en chef-conseil de la Compagnie des chemins de fer de l'Ouest français.

---

## QUESTION V.

---

## CONTENTS

---

	Pages.
Sectional discussion . . . . .	1099
Sectional report . . . . .	1161
Discussion at the general meeting. . . . .	1161
Conclusions . . . . .	1172

### PRELIMINARY DOCUMENTS.

Report No. 1 (all countries, except America), by Édouard SAUVAGE. (See the *Bulletin* of December, 1904, p. 1639.)

Report No. 2 (America), by J. E. MUHLFELD. (See the *Bulletin* of March, 1905, p. 1075, and of April, 1905, p. 1614.)

Vide also the separate issues (in red cover) Nos. 17 and 41.

---

## SECTIONAL DISCUSSION

---

**Meeting held on May 5, 1905 (morning).**

---

**Mr. ED. SAUVAGE, PRESIDENT, IN THE CHAIR.**

**Mr. J. E. Muhlfeld, reporter for America :**

I am grateful for the privilege of taking part in this Congress. The honor of having been appointed by the Permanent Commission to report on such an important question is thoroughly appreciated, and it is perhaps fortunate that the duty has come at a time when the railroad with which I am connected has taken up in a substantial manner the development, and investigation of the actual operation, of a tonnage locomotive of great power for special mountain service, which has given an especially good opportunity for treating the subject in a practical manner.

During the present period, when the facilities of many railroads are taxed to their limit to move the tonnage which originates along their tracks, to the Operating, more than to the Traffic Department, is assigned the duty of increasing the revenue which must be derived from the handling of a ton of freight per mile hauled.

An American locomotive of great power may be described in a few words as one capable of developing, when properly designed for the speed requirements of passenger and suburban service, at least 20,000 pounds in the cylinders at starting, with provision in suburban service for rapid acceleration, and for freight, helper and switching service, at least 40,000 pounds.

Locomotives are now expected to perform equally well work of the most varied and exacting nature, and the requirements in the way of faster schedules and heavier trains in passenger and freight service have, in connection with lack of substantial maintenance, exceeded the development of the increased power in the machine. Speed limits and train loads are increasing each day and will no doubt continue to do so, as the maximum expansion of car equipment and the length of trains, under favorable conditions, have not yet been reached.

How well the demand can be met in one steam locomotive of the present gauge and clearance limits by simplicity in design, flexibility, maximum proportion of adhesive to total weight, good material and construction, pure heated feed water and quickened circulation, compounding, superheating, substantial maintenance, intelligent operation, and other essentials, is a question that must be determined in the very near future, and from this determination will proceed the conclusion as to the proper proportions of each type of locomotive required in the motive power stock for a large, modern railway system.

While there is every necessity for the simplification of the American locomotive design, still

the sub-division of the present excessive stresses, which may involve the increasing in number of the parts of locomotives that are expected to develop great power, should not be discouraged, so long as the total number of parts and the proportion of non-adhesive weight per unit of tractive power developed, are decreased when compared with present practice.

There are many features in foreign locomotive practice that the American railroads should consider. Among these are : distribution rather than concentration of stresses; lightness of reciprocating and revolving parts; more effective distribution and utilization of steam; reduction of weights that must be balanced; thoroughness and substantiality in the new construction and repairs and increased efficiency in the care and operation. The extraordinary expense involved in the initial and maintenance costs for excess weight, due to indifferent designs or the use of cheap material, and the excessive wear and tear or failure caused by the unbalanced weights, are items that have been too greatly disregarded in the more modern American locomotive practice. The fact that long distance, fast or heavy tonnage runs have been recorded, does not prove by any means, that the present locomotive meets satisfactorily the demands upon it for high speed and great hauling capacity.

During the past few years, the unequalled growth of the country has created a demand for new and repaired locomotives that has taxed the manufacturing and railroad shops to their capacity, and the stimulating of output has prevented the proper study and preparation of details in design, distribution of material and workmanship. The wheel arrangement and weights per wheel, with the general enlargement of boilers and grate areas for the purpose of meeting the demands of a cylinder capacity that should produce great tractive power, have been given the preference to all factors involved in the promotion of a locomotive of a really increased efficiency and economy.

Many of the improvements in locomotives have too often resulted, through the application of theoretical, rather than practical ideas, in increased ineffective weight, numbers of parts and costly complications. The elimination of experimentation and indulgence in those individual preferences, fads, patented devices and frills which have no practical value, would materially reduce the initial, maintenance and operating costs, and vastly increase the earning capacity of the locomotives, through a service that should be given without the proportionate increase in the cost, as in the capacity of the power.

While a heavier unit of power has produced a reduced operating cost during the time that it has been used on its new built account, and when the capacity of the railroad was measured by the old and inadequate facilities and conditions, as expensive betterments and repairs have become necessary, the cost for maintenance and to enlarge and improve the facilities has over-balanced the net results that have been predicted and anticipated.

Railroads are not operated to save fuel, or to have locomotives that it does not cost much to maintain and run, and while economy must be considered as secondary to getting trains over the road, at the same time, the tractive power required and the limits given within which to acquire this, make it necessary that locomotives be now so constructed and maintained that more work will be derived per unit of fuel and the result should be economy. Whether the economy will be derived through the use of turbine, internal combustion, pneumatic or electric locomotives, or by a practical development of the steam locomotive from the use of improved boiler, motion gear, superheating, compounding, balancing and other essential features, remains to be determined.

The time has arrived for the railroad mechanical engineers to become more alert and study and assume their responsibilities along the broadest lines. Those lines are not limited by the

shop confines, but extend into the very pocket of the stockholder. Each such engineer should learn what every month of a locomotive out of service means in loss of revenue, and he will no doubt be impressed with the greatness of his work and of the interests that may be affected by hasty conclusions and departures from conservative practices. The broader problems and the refinements in design and construction must receive more thorough attention, and experiments should be carried out with precision, on a limited scale, until the practicability of the device under the varied local conditions has been demonstrated beyond any doubt.

Now that many of the older railroad systems are nearing completion in mileage, the capital charges have risen to as high a level as can be borne by the business originating, and, as the maintenance of equipment out of revenue has become a matter of increasing urgency, errors due to design, or too much experimentation, can no longer be so easily and conveniently covered by large contributions for new locomotive stock.

It is a fact that electricity as a motive power is superseding steam, in many cases, for the handling of suburban passenger and freight traffic, and that it may displace the latter for through passenger service, but it will be some time before electrical energy will supplant steam power for the handling of heavy tonnage for any considerable distance. While the construction and operation of electrical locomotives is still in an experimental stage, their performance during the past year under varying weather, rail and service conditions, when compared with steam locomotives, show a cost which will make their use prohibitive, when fuel must be used to generate power, except in cases of absolute necessity.

Therefore, in preparing the design for a steam locomotive of great power for to-day, such design and construction must be adhered to as will not only fulfil the present speed and heavy tonnage requirements, but which will remain modern for several years to come, and combined in the constructive features must be a boiler and motion gear that will insure the most conversion into energy per unit of fuel consumed, and result in the greatest efficiency and economy with respect to the maintenance and operation.

A discontinuance of the present prosperous conditions of this country and its railroads, and a continuance of some of the wasteful methods of railroad operation, would soon result in losses which would not occur had more consideration been given to the attaining of an economical locomotive service in connection with an efficient one.

This report is based on data that have been forwarded by the affiliated managements and locomotive builders, and as found in technical papers.

My conclusions are the result of investigation and of general opinions advanced by those directly concerned in the design, building, maintenance and operation of locomotives of great power for American railroads, embraced with the views of my department associates and of myself.

The following are the conclusions :

1° Locomotives of great power, within the present clearance and weight limits, may be designed and constructed to remain modern for several years and produce a higher average speed and tractive power with less cost for locomotive expenses per unit of power developed, than that given by locomotives of large capacity in use to-day or from the previous lighter equipment ;

2° The efficiency and economy predicted and anticipated from the use of locomotives of great power, have not been attained. Their development has been too rapid on the basis of the theoretical calculations which did not include the necessary factors for practical results, and also owing to the disregard of simplicity in design, substantial maintenance and speed as elements of economy ;

3° Locomotives of comparatively recent construction have been built without proper consideration for the use of railroad standard designs, specifications, practices and processes which continued experience may have determined to be more suitable and interchangeable than the standards of locomotive builders;

4° The present ineffective load should be reduced by the use of design and material which will combine the least weight and greatest desired strength;

5° The elimination of those individual preferences, patented devices, fads and frills which have no real value, by the use of simple, practical design and construction, will produce more satisfactory general results;

6° The mechanical department supervision has often been curtailed when expansion of organization and direct mechanical control should have been given to insure the desired performance. Changes in organization and methods have frequently been effected in preference to conservative management, with instruction, education and substantial recognition for the deserving rank and file;

7° The locomotive maintenance and dispatchment facilities have not always been developed to meet the proportionate increase in the locomotive dimensions, capacity and requirements, while slow line movement has made it necessary to increase average mileage by reducing terminal mechanical delay, during a period when more opportunity for maintenance and handling has been essential;

8° The tonnage hauled per train has frequently precluded the making of an average speed between initial and destination terminals that would be productive of efficiency and economy in locomotive operation;

9° Decreased efficiency has resulted from the irregular transferring and crewing of locomotives for long runs. The regular assignment of crews to locomotives and of suitable locomotives to shorter runs on regular districts, should accomplish the best results;

10° Provision for the cleanliness and care of employees and equipment on the line and at terminals, should receive more consideration;

11° Personal supervision and investigation should govern in the construction and operation of locomotives of great power, whilst statistical information and correspondence should be limited and used with caution.

**The President.** (In French.) — Gentlemen, you have just heard Mr. Muhlfeld's remarkable report, which, in a masterly manner, explains all the conditions which locomotives have to satisfy; these have been considered, not only from the somewhat narrow standpoint of their construction as steam engines, but all practical questions relating to the use and distribution of locomotives over a railway system have been regarded.

We shall now go on to examine these different conclusions, taking them up one by one.

You are now at liberty to discuss the first conclusions concerning the use of the patterns of locomotives that would seem most suitable, the employment of very high steam pressures and the results of using the compound system. According to Mr. Muhlfeld there is more to be done in this direction.

We have undoubtedly here engineers who can help us with their experience in this respect.

**Mr. J. F. Deems**, New York Central & Hudson River Railroad. — **Mr. President**, I regret that I have not been able to give the paper the attention that it deserves. Consequently I shall not undertake to discuss it very much in detail. It seems to me, however, that **Mr. Muhlfeld** has approached the subject in the right spirit. He starts out by calling attention to the fact that railroads are not operated to save fuel. I think all of us have, from time to time, been impressed with the fact that some of our technical writers and some of those connected with railroads, do not seem to appreciate the fact that not only the locomotive is not built to save fuel and that the railroad is not run for the purpose of saving fuel, but that the railroad itself, as a whole, is simply a machine for the moving of freight and passengers, and it may not unfrequently happen that the locomotive, which on a certain basis of calculation may be the most expensive in fuel, may be on another basis the most economical. It is not uncommon for a shop, for a factory of any kind, which is operated at a very high hourly wage rate, to be much more economical in output than one that is operated at a low hourly wage rate, and this fact, I think, in connection with the operation of locomotives, has not been given the attention it has deserved. I am very much gratified to see that my friend **Mr. Muhlfeld** has started out in his paper with that statement. It of course goes without saying that we want to get the greatest output for the smallest outlay.

One thing that occurs to me in connection with what is said on page 100 of the report <sup>(1)</sup> is the possibility of a successful locomotive stoker. I have felt for the last year or more that there is perhaps not any one piece of mechanism that to-day is deserving of so much attention by men connected with locomotive operation, as is the development of a successful locomotive stoker.

I wish to refer at this time to another point which is brought out in the paper. On page 114 **Mr. Muhlfeld** says <sup>(2)</sup> :

The tendency of the present period being to produce the maximum hauling capacity per unit of power, one of the simplest means to effect this has been the increasing of steam pressures to provide for the greatest tractive effort when locomotives are started at slow speeds.

In that connection — and I have talked to some of the locomotive builders about it — an important piece of mechanism which is not receiving the attention that it deserves is a traction increaser. A number of them have been produced and used from time to time, but so far as I know they have all been abandoned. I may not be exactly right in that, but I think as a general statement that they have been abandoned. They have not been continued, at least. I cannot help thinking that this is something worthy of a good deal more attention, a good deal more persistent effort, than has been given it. As I say, I have talked to a number of locomotive builders, but they do not seem to give the matter a great deal of attention.

---

<sup>(1)</sup> Vide *Bulletin of the Railway Congress*, No. 4, March, 1903, p. 1116.

<sup>(2)</sup> — — — — — p. 1130.

On page 113 and at the top of page 114, reference is made to the various designs of compound engines, and favorable comment is made on the four cylinder balanced type with crank axle for high speeds, and I hope that Mr. Muhlfeld's expectations will be entirely borne out in that respect. I cannot, however, help feeling that it will take some years yet to determine that point, and it seems to me that the question of a crank axle with the tremendous high speeds and the heavy service that our locomotives are subjected to to-day, is one that gives us reason to doubt the successful outcome of that particular device. We know for a fact that years ago when the crank axle was used it was a source of a great deal of trouble and expense and it was finally abandoned. We will admit of course that the crank axle as built to-day is very much superior to those used at that time. We must not, however, forget that our locomotives to-day are subject to very much heavier strains, very much harder service than they were at that time, and I am inclined to think that it will take some time before we can feel entirely secure in the use of the crank axle in connection with the four cylinder balanced compound. I think the principle is right, but as to that particular part of it, I do not feel quite sure as yet.

I notice in the second conclusion that Mr. Muhlfeld goes on to say...

**The President.** — I would suggest to the gentleman that we first confine ourselves to the first conclusion, and if he has no objection to it we will take the whole thing in order. Do you not think it will be better to take each conclusion in succession?

**Mr. J. F. Deems.** — Very well. I have no objection to that.

**The President.** (In French.) — On the question of mechanical stokers, no doubt some of the engineers present will be able to supply us with interesting information. Our American colleagues will, I expect, be able to provide us with useful information in this respect. Can we regard these appliances as likely simply to facilitate the work of the men or as also capable of making an appreciable difference in saving fuel?

**Mr. J. F. Deems.** — Mr. President, I regret to say that I cannot give very much in the way of detail either as to the construction or operation of mechanical stokers as applied to locomotives. While they have been in use, as doubtless every one here knows, for the last five to seven years, there seems to have been but little progress or advance made in the development of the machine until within I should say the past ten or twelve months. I feel, however, that within that time quite a good deal has been accomplished and I think a much keener interest is being taken by the railroads and the railroad officials, and I think they are much more willing to encourage the work and to permit experimentation with them on the locomotives than formerly; but I could not give the matter in detail as I have had no personal experience beyond one or two trips on an engine equipped with a certain stoker.

**The President.** — I should like to ask Mr. Deems whether he thinks that these mechanical stokers are useful in promoting economic working.

**Mr. J. F. Deems.** — Well, in the present state of development, I would not expect any marked economy. I think, however, that will come in time. I feel quite sure it will. The first consideration, at the present time, is to do something that will enable us to fire the very heavy locomotives more easily than is being done at the present time. The second consideration, more economical work, I think will follow. I feel quite sure that will be true. I would not anticipate that, however, in the present state of the art.

**The President.** (In French.) — Perhaps Mr. Muhlfield will kindly give us some details about mechanical stokers?

**Mr. J. E. Muhlfield, reporter.** — Mr. President and delegates, the Baltimore & Ohio Railroad has several mountain divisions over which they have to operate heavy trains of freight, trains of a maximum capacity, and we have had quite a number of investigations made relative to the operation of mechanical stokers. All of them have been over feed stokers adapted merely for the purpose of relieving the firemen of extreme physical requirements. We have never put into service any of these automatic stokers for the reason that our investigations have not, in our opinion, justified our going to that expense or into the matter to any extent whatever. I have always thought from the developments we have made on the Baltimore & Ohio Railroad in connection with the handling of heavy service, that it is more desirable to first reduce the consumption of fuel by a greater economy in the use of steam. There are quite a number of features in the way of compounding, superheating in a better distribution of the steam in simple locomotives that we think can be further developed. We have had considerable experience in compound locomotives of the cross compound and four cylinder types. We have had no experience with the balanced compound types, but under our conditions the compound service has not been favourable. The design in some instances has not been what we have thought was the best to get proper results under our conditions, mainly on account of the large amount of drifting over rolling country. The cross compound type has given fairly satisfactory results on some level divisions, where we have long divisions, 128 to 151 miles in length, and the cross compounds have given us some result in the way of fuel and water economy. The cost for repairs has been high, mainly for the reason that the design of boilers was not such as to best meet the water or the service conditions we have on those divisions, in connection with very severe winter weather. We have not obtained satisfactory results and, as I have said, our opinion has been up to the present time, and in consideration of the developments that have been made in hauling capacity per unit locomotive power, that we should first try to utilize to the greatest advantage the use of steam by proper distribution in simple cylinders. That is the more preferable, but

if in such way we cannot reduce the fuel consumption to within the limits of the ordinary endurance of a fireman, then we should go to superheating or a system of compounding, which has been tried out and it is known to give fairly satisfactory results. The present locomotives, when it comes to fuel consumption over heavy grades, and in connection with heavy tonnage, have used an extreme amount of coal per mile run. The length of trains and the tonnage in trains are constantly increasing, and the cost for repairs, together with the cost for fuel consumption, seem to develop in about the same ratio as the tractive power. While I agree with Mr. Deems that it will probably be necessary in the future to develop a mechanical stoker, if that is done it should be an underfeed stoker. It seems to me that while relieving the fireman of his duty of shovelling the coal in on top of the fire will reduce the amount of physical labor, it will not produce the results in economy or efficiency that we should expect from a mechanical stoker. I think that when a mechanical stoker is developed, it should not only relieve the fireman of some of his physical duties, but it should also give us a greater efficiency and economy in the locomotive. That would have to be the result to account for, in the first case, a complication, and in the second case increased maintenance expense both of which would naturally occur. Before any great application is made in a mechanical stoker, I think that the better distribution of steam in simple cylinders, and superheating and cross compounding should be tried with the very best designs in order to get the results from that system first.

**Mr. D. F. Crawford**, Pennsylvania Lines West of Pittsburgh. — The line with which I am connected has made some experiments with the automatic stoker, but up to the present time, I am not prepared to recommend the adoption of the stoker that we have tried, principally on account of the fact that the design is such that the fireman, in my opinion, is not relieved of the hardest part of his labor, *viz.*, lifting the coal. I think there is a limited field for an automatic stoker for a locomotive, but I agree with Mr. Deems and Mr. Muhlfeld that it will be some time before it is developed satisfactorily. At the present time, the demand is entirely due to the desire to reduce the work of the fireman. Later, the demand will come on account of economy. The underfeed stoker referred to by Mr. Muhlfeld, in my opinion, is very promising, and I think such a stoker will be used on a locomotive within a very short time. If it is as successful as expected, it will be on the basis of economy more than on the basis of relieving the fireman. The experiments we have made so far with stokers, show that, under conditions of very steady loading, the stoker will show a slight economy, but if the division over which the locomotives run is in rolling country, requiring considerable variation in the steam pressure, the stoker is not so economical as hand firing.

**The President.** — The section will doubtless listen with interest to the opinion of Mr. W. Forsyth, who is well known as the former mechanical engineer of the Chicago, Burlington & Quincy Railroad, and is one of the editors of the *Railway Age*. He

has followed the development of the locomotive stoker in this country, and he agrees with what has been said here. The subject is receiving more interest and encouragement from railroad men at the present, and the result is that quite a number of stokers are being developed. The objection mentioned by Mr. Crawford, in requiring the fireman to handle the coal to the stoker, has already been provided for in one which has a conveyor, which brings the coal to the stoker by power. The delegates may be interested in seeing in operation on the exposition grounds one of the principal stokers which has been used in this country, and they will see how successful a steam device is in distributing coal uniformly over a rather large area. Mr. Forsyth says that it appears to be evident that a machine which will under heavy work distribute coal evenly and over the surface of a large fire box, and prevent the air from coming up through the irregular bed due to hand firing, must result in an economy of fuel, and that he believes will be one of the important results of mechanical stoking. Manual stoking on a line having heavy grades is often unsatisfactory. A fireman starts out on the trip fresh, and he then is able to do his best work, but as the labor increases and time goes on, he becomes fatigued and gradually neglects that careful work which is required, and the result is that the steam pressure is not maintained, the speed is reduced and a successful trip is often impossible with such large engines. Mr. Forsyth thinks that it seems quite probable, therefore, that the machine stoker which will distribute coal uniformly must result in an economy not only in fuel but in train operation.

**Mr. G. F. Bidwell**, Chicago & North Western Railway. — Mr. Chairman, I have a question which I would like to ask. I would ask the gentlemen who have been giving us so much information on this question of the mechanical stoker, if it is expected by any of them that the mechanical stoker will enable us to dispense with the fireman on the locomotive, as he is called in this country, and stoker, as he is called in Europe.

**Mr. J. F. Deems**. — Mr. President, I will say that I have talked this matter over with railroad men from one end of the country to the other, and I have not as yet found anyone who entertained any such idea. I do not think that result is expected or contemplated by anybody.

**Mr. F. G. Wright**, Great Western Railway, Great Britain. — Mr. President and gentlemen, I should like to say that on the Great Western Railway of England, we have tried mechanical stokers, and our experience has been that we get no better results and no further economy than you do by hand firing. The stoker has been tried on two separate classes of engines, and in each case the fireman preferred to put the coal on in the ordinary way rather than by putting it in through the mechanical stoker, because with the mechanical stoker, the man is obliged to lift the coal higher up than he would if he fired by hand. Before this mechanical stoker was tried on locomotives, we tried mechanical stokers on stationary boilers, and had

precisely the same experience. It seems to me that with mechanical stokers, unless you are able to handle the coal without any human aid, except perhaps opening the hoppers of the wagons, mechanical stoking is a failure. You can do far better by hand firing than by mechanical stokers, unless you are able to do it entirely by the stoker. That is to say, you must not touch the coal by hand after it leaves the truck.

With regard to locomotives, it is a difficult problem to solve in such a way that after the coal is once placed on the tender you will be able to handle it by the mechanical stoker entirely, without the fireman touching the coal at all. That is a very difficult thing to do. The question of underfeed stoking we are now experimenting with on stationary boilers, with a view to trying it, if we find it successful, on locomotives, but, with the amount of space so limited and the construction of the tender, which has to provide for carrying water as well as coal, it is a difficult matter to arrive at a mechanical stoker which will answer all the requirements of a modern locomotive. Until that is done, hand firing will hold its own for some years to come.

In regard to the question of modern locomotives of large size and powerful dimensions, they are only economical on our railways when they are working up to the limit of power for which they are constructed. That is to say, if you have a powerful locomotive handling a light train, you are doing so at a very unnecessary expense compared to handling it with a locomotive of less dimensions. I do not know how it is in America, but the difficulty in England is to be able to form trains that are of sufficient weight for the modern locomotives of such large dimensions to handle with economy. Unless the trains are of full load, the working of these modern large sized locomotives is very expensive compared with the smaller sized ones. There is at the present time an effort being made to run goods trains in England of sufficient weight for these large locomotives to handle. When that is done, we shall find an enormous saving in labor and also a saving in oil and coal and the necessary stores required to work a locomotive.

**Mr. A. W. Gibbs, Pennsylvania Railroad.** — Mr. President, I think one of the principal points in regard to the stoker has been entirely overlooked, and it is this, that one of the reasons for the great cost of maintenance of our large engines is the lack of intelligence on the road. At present with these large engines, no man but a very large man can do the work. The firemen of to-day are the engineers of to-morrow, but where we have to select men for muscle alone, that is, for their capacity to shovel so much coal per hour, later on we shall have to depend on their intelligence as runners. It therefore seems to me that the question of the economy of coal, if any, to be effected by the mechanical stoker, is but one of the features to be considered, and that what we want more than anything else is intelligence in the running of our locomotives and their care, and, consequently, in the repair of them; and any device that will tend to put men of intelligence, though of light physique, on a

parity with those who have strength alone, is very desirable. It strikes me that that is the most important feature, and that is what will, if anything, justify the use of the stoker.

**Mr. Laurent**, Orleans Railway, France. (In French.) — Will somebody tell us, Sir, what is the hourly consumption of coal per unit of area on the American locomotives with mechanical stokers — in other words, to what hourly consumption of coal do the Americans find mechanical stokers correspond?

**Mr. J. E. Muhlfeld.** — Mr. President, from the discussions that have been heard on this subject, the requirements of a good mechanical stoker are greater efficiency, economy in maintenance and operation and reduced physical labor on the part of the fireman. It has been determined that we can secure one steam locomotive unit, with hauling capacity, in compound gear of about 75,000 pounds tractive power. That has been done without the use of a mechanical stoker or taxing to the limit of physical endurance a competent fireman, and without the use of any special grade bituminous coal for fuel. It is dependent largely on the further development of locomotives, as to whether or not a mechanical stoker is required. If we can develop in one locomotive 75,000 pounds tractive power to handle trains over the line at an ordinary speed for freight trains, with a good fireman who has the physical ability to meet those requirements and give sufficient of his attention to signals and to assisting the engineer in the duties he has to perform, we would fully accomplish the result. As I have said, we know that in the handling of through trains that require a tractive power of 75,000 pounds to haul them, we can get one fireman to handle a locomotive which has ample grate area to a given amount of fire-box and tube heating surface, and make use of the cross compounding system. If the development of locomotives must become greater than what has already been done, we shall have to increase, I think, the gauge of the track, and the clearances, and the height, width and length in general of the despatchment and terminal facilities all the way through, would have to be remodeled. Whether that would be advisable or necessary, is something which remains for the present and also for the future to determine. So far, I think that locomotives of that capacity would not be adaptable to the ordinary dead freight requirements. The limiting feature is the length of trains and the tonnage per train that can be handled over the ruling grades. That has been the limiting feature so far as the Baltimore & Ohio is concerned, and as long as we can get a locomotive that will use less fuel through a better distribution of the steam by superheating or cross compounding or both, I think it is more advisable to go into complications that would be involved on account of those features, than the complication and expense of mechanical overfeed or underfeed stokers. The application of a stoker is bound to complicate as it will mean additional parts to the locomotive. It will be liable to failure and application will have to be made, so that in the event of such you can resort to hand firing. Besides, unless we go to an underfeed stoker, so that the coal can be conveyed to the hoppers

automatically by gravity, it would necessitate a conveyor system to handle the coal to an overfeed stoker, which would mean much more complication than the results would warrant.

**Mr. Laurent.** (In French.) — Mr. Muhlfeld has not given the information I asked for just now but the subject will crop up again when we are discussing locomotive power.

So far, we have done nothing in France in this direction, and that is why I demanded fuller explanation.

**Mr. J. E. Muhlfeld.** — Mr. President, I cannot say just how many locomotives have been fitted up with mechanical stokers in the United States, but I think it is in the neighbourhood of fifteen or twenty. Am I not right, Mr. Deems?

**Mr. J. F. Deems** — It does not exceed that number very much.

**Mr. J. E. Muhlfeld.** — This development of 75,000 pounds tractive power was made during a temperature that was in the neighbourhood of zero — that is, when the water was just a little above freezing, say about 33°, and there was an average of about 2,700 pounds of coal consumed per hour, which would be about 60 pounds per square foot of grate.

**The President.** (In French.) — Has anybody anything else to suggest on this subject? If not, we will take up the second conclusion. Will the principal secretary kindly read it.

**Mr. Boell,** *principal secretary.* — The following is the second conclusion :

“ 2° The efficiency and economy predicted and anticipated from the use of locomotives of great power have not been attained. Their development has been too rapid on the basis of the theoretical calculations which did not include the necessary factors for practical results, and also owing to the disregard of simplicity in design, substantial maintenance and speed as elements of economy. ”

**The President.** — Now, I believe that Mr. Deems has something which he wishes to say on this subject.

**Mr. J. F. Deems.** — Mr. President, if I may be permitted, I should like to first refer to what has just been spoken of for a moment. Mr. Muhlfeld has spoken of an engine that develops 75,000 pounds tractive power, and that there was little difficulty in one fireman maintaining the pressure. Now, I want to ask if that condition prevails in ordinary everyday service, and for this reason. In service conditions, that engine ought to haul from 5,000 to 6,000 tons over a comparatively level line, and in service conditions in order to keep out of the way of passenger trains and others, either on a double or a four track line, it would have of necessity to go at a speed of from 25 to 35 miles an hour, and even higher than

that very often. I just want to ask Mr. Muhlfeld if his engine of 75,000 pounds tractive power was in ordinary service conditions such as I have described, and if it was possible for one fireman to maintain steam?

**Mr. J. E. Muhlfeld.** — Mr. President, the tests have been made both in pusher service and in through freight service. With the maximum trains we handled in the through service, the average time on the road was about nine hours, that is, in covering all the trips during which the tests were made, and the consumption of coal per square foot of grate per hour averaged about 60 pounds and the consumption per mile run was about 475 pounds. The speed was about 10 miles an hour. We made the test during the most unfavourable conditions, that is, during severe winter conditions. We have had a pretty severe winter during the last year, a good deal of freezing weather and a good deal of snow, and there has been a great deal of time that the locomotive has been standing around on the side tracks, and such conditions, I think, are more severe than where you can keep the locomotive moving. It seems to me that if we can start a locomotive from a terminal for a trip say 100 miles, or any length within reason, and keep it moving, we can get more satisfactory results in fuel consumption than where it is lying on a side track, especially where run of mine quality of fuel of the ordinary bituminous grade, which clinkers considerably, is used.

In continuation of that reply, I might say that this locomotive has driver wheels 57 inches in diameter. For road service and higher speed we should not consider less than 63 inches, which would facilitate the speed and the movement, and at the same time reduce the number of cylinders full of steam required per mile, and which would tend to reduce the fuel consumption.

**The President.** — Will Mr. Deems say something about the reporter's second conclusion?

**Mr. J. F. Deems.** — Mr. President, I notice in the second conclusion that Mr. Muhlfeld says as follows :

The efficiency and economy predicted and anticipated from the use of locomotives of great power, have not been attained.

I am rather inclined to take issue with Mr. Muhlfeld on that. I think while we perhaps have not gotten all that we would like to get, yet we have very good reason to feel a degree of satisfaction with what we have attained with the larger power. In the statements that we get from month to month and year to year on the lines with which I am connected, we show each year perhaps a smaller number of freight trains handled and a very largely increased tonnage. That has been very noticeable. I cannot give any figures, but I feel that the large power is giving a very good account of itself.

Now, there is one point here that I should like to refer to. On pages 88 and 89 of his paper, Mr. Muhlfeld says <sup>(1)</sup> :

While the provision for tube heating surface has been quite liberal, the development of grate area and fire-box heating surface has been retarded. Long, narrow and deep water legs, resulting in restricted circulation and burning of sheets, together with designs that do not provide sufficient flexibility for the plates, seams and joints are largely responsible for the cracked sheets, leaky and broken stay bolts, and leaky seams, that are now so prevalent in fire-boxes, as to seriously interfere with the performance of the power.

Less than a month ago, my attention was called to a case on one of the properties I am connected with, where the long *narrow* and deep fire-box, in locomotives carrying 200 pounds pressure, had lasted twice as long as the wide fire-box with much more ample water space. I confess I was quite surprised at that, and it was not in one instance, but in several. My attention was called to the fact that the narrow fire-box resting above the frame and extending out to just the outer line of the same, was lasting twice as long as the very wide box extending beyond the frame with the same steam pressure in the same territory and in the same service. Really it was such a surprise to me that I have been, I might say, lying awake nights about it. I cannot understand it, and I just noticed that on this paper. It seems to me that is something well worthy of serious consideration. The wide fire-boxes are being replaced after making a very limited mileage, while the others are running and have not been developing any cracks or trouble of any kind at all.

On page 95 of his paper, near the bottom of the page, he says <sup>(2)</sup> :

... While arrangements which have been found complicated and impracticable, although theoretically correct, will be and are being abandoned for the best interests of the general service by a practical solution of the details to meet local conditions.

That is something, it seems to me, which is worthy of a great deal of attention. There is too much of a tendency to add parts, and when one of our good friends the supply man comes in and talks to me about adding something to the engine, I tell him, no, we are paying men for telling us how to throw something away, to get rid of a part and not to add anything. I think that is a matter that is deserving of the most careful thought on the part of everyone connected with locomotive designs. I notice about the breaking of cylinders. As long as five years ago I took up the question of making cast steel locomotive cylinders. The present tendency or practice is to bush almost all locomotive cylinders, even though they are of cast iron. We also put a cast iron bushing in the valve chamber. The thought occurred to me that we might lighten the weight of the cylinders and get them much stronger by using cast steel. At that time we could find no one who would agree to make a cast steel locomotive cylinder except from a very small pattern, but within a month

---

<sup>(1)</sup> Vide *Bulletin of the Railway Congress*, No. 4, March, 1905, p. 1104 et 1105.

<sup>(2)</sup> — — — — — p. 1111.

I have found one firm willing to undertake the manufacture of cast steel cylinders of the very largest and most complicated designs, and they are willing to make the patterns and take the responsibility. They will make the patterns and machine these cylinders and take the entire responsibility of delivering to the railroads a perfect cast steel cylinder. This seems to me worthy of some consideration. I have consulted with another prominent steel expert, an expert in the manufacture of cast steel, and he doubts whether it can be done. So that the matter is rather open as yet, but so long as you can find a reputable manufacturer who is willing to take the responsibility, it is, to say the least, encouraging, and it seems to me that that is worthy of consideration in connection with what Mr. Muhlfeld has said about the breaking of cylinders and about reducing the weight.

Another point under the second conclusion that I desire to refer to was the use of the Walschaerts valve gear, or some valve gear that will enable us to dispense with the enormously heavy eccentrics, and eccentric straps, etc., of the Stephenson gear. That is, in my opinion, one of the developments that we should be giving a great deal of consideration to. My attention was called the other day to a locomotive of very heavy capacity, on which the Walschaerts valve gear had been placed, and the reduction in the weight was about 1,300 pounds. This is quite an important matter, and the results obtained were very satisfactory.

I also want to endorse what Mr. Muhlfeld has said concerning the tendency towards higher driving wheels and dispensing with the lower wheel. That of course becomes necessary as traffic on the lines becomes more dense, and it is more difficult to keep the freight trains moving and out of the way of the passenger trains. It is forced on the attention of everyone at the present time except on such lines where there may be a class of coarse freight which is handled slowly.

**Mr. R. P. C. Sanderson**, Seaboard Air Line Railway, United States. — I can side with Mr. Deems with regard to the success which has followed the use of large power. I think I am justified in saying that with three years' use of heavier power I can show figures regarding general expense and increased earnings, in favour of the treasury. There is only one standpoint from which we should look at this question, and that is the nett dollars which go into the box of the treasurer of the company. All tests, every set of statistics, must be subject to that one standard, and I can say with confidence that we can show a distinct gain in that direction as the result of the use of heavier power.

With reference to cylinder breakage, I think it is right to make all cylinders bushed. You need a different iron for your cylinder proper than you do for the wearing surface of that cylinder. The cylinder bushing ought to be made with about 20 or 25 per cent wheel iron, white iron. The cylinder itself should be of tough gray iron with a certain percentage of steel scrap and some charcoal iron. I was troubled at one time with broken cylinders which were quite mysterious as to the cause of the breakage, and to find the reason I reconstructed the cylinders in

models  $1\frac{1}{2}$  inches to the foot, in stiff drawing paper almost exact duplicates of the actual cylinders, and tested and wrenched them until I made the brittle paint on the paper crack in the same place that the cylinders broke. I found in this way the reasons for the weaknesses in cylinder design and changing the ribbing and altering the cylinder somewhat was able to eliminate these breakages altogether.

With regard to obtaining results through the use of large engines there are two principal things you must look at — one is steam, you want steam; more boiler, and still more boiler. Then you want to give the man a reverse lever which he can handle. Take these large engines,  $22 \times 32$ , with 200 pounds and over of steam, with a slide valve, no matter how well balanced, if the engineer undertakes to change the lever in the rack to correspond with the grades, the chances are it will throw him out of the cab window and he does not like to handle it. The consequence is he leaves it alone. If you give him a well balanced piston valve, a thing which he can handle, he will use it and accomplish a great deal more than you can with the most refined valve motion he cannot operate. That is an important thing, in my opinion — if a man has a thing to operate and cannot easily work it under the extreme conditions of heavy service, it will result in a loss of economy instead of an advantage.

**Mr. W. McIntosh**, Central Railroad of New Jersey. — The road that I am connected with, the Central Railroad of New Jersey, commenced to purchase large power about six years ago, and we have a considerable proportion of that type of power in service now. Our first experience with the large locomotive was unfavourable, for the reason that it was not very well developed when it came to us from the manufacturers' hands, and we found that our motive men, I might say our engine men, did not take kindly to it for the reason that it was much larger than what they had been accustomed to, and certainly it was more difficult to handle than they had experienced with the older and smaller type of engine. We gradually overcame the prejudice of the men, and improved the weak parts of the machines to such an extent that we secured very satisfactory results, and we have continued in that direction until we now have the engines brought up to a standard which meets our requirements very well. There is no question about the value of large power to a railroad corporation. We have increased our loads materially and in proportion the large power has materially reduced the cost of operation.

**The President.** (In French.) — In following Mr. Muhlfeld's conclusions, it appears that he regards the compound as the locomotive of the future. It would be interesting to know whether his view is supported by the majority of the members, or if there are any opposite views held.

**Mr. J. E. Muhlfeld**, *reporter*. — I feel that the cross-compound engine in connection with superheating, or without, will under unfavourable weather and water conditions, and where the cost for fuel is high, give an efficient service with greater

economy, that is, for maintenance and operation, than may be derived from simple locomotives; but where the conditions are favourable in the way of fuel, water and weather, and where you have mountainous lines or rolling country, there is no doubt but that the simple engine in the cost of operation and earning capacity to the railroad company, as a whole, will give most satisfactory results. Mr. Deems and the other gentlemen made the point that the large locomotives in service have given the degree of efficiency and economy which had been anticipated from them. Many factors enter into that — first, how long have the new locomotives been in service; again, over what sort of territory and at what speeds do they operate; also, what are the weather, the water and the fuel conditions — all these factors must enter into the proposition. On our road, the average length of service of an engine runs over a period of about ten years, which means that we have much modern stock in the service. We have the level country and also the mountain service conditions and a sufficient number of locomotives of all types to form a conclusion as far as our local conditions are concerned. The modern types have been in service from five to nine years, a majority under high steam pressure, operating under all sorts of conditions. Some of these locomotives have given good results, and others have not, largely due to design, material and construction, and often due to operation.

When you come to average the annual cost for maintenance, cost for renewals and cost for betterments for a certain term of years, we have not been able to see where the modern locomotives have given us the service we should have expected from the added investment or capitalization. Comparing these results on the Baltimore & Ohio, as well as on other railroads, for which we have received statistics, it would seem to indicate that where you have unfavourable conditions and where the lighter class of power under favourable conditions have given fairly satisfactory results, the modern locomotives when their use is inaugurated, have not been as successful as they should have been. On lines where they have given satisfactory results it is no doubt due to good designs, construction and operation and all factors embodied in the locomotives as they should be. In some cases that has been the case and in others it has not. When it comes to the results which can be accomplished by the application of large tractive power, I am of opinion that there is considerable room for improvement, and I believe that the results to be forthcoming in the next ten years, will be more satisfactory than what has been accomplished up to the present time. It is natural that it should be so. Taking the experience we have had in the past few years, and the opportunity for working out the various factors, I think that it should result in better performances.

Taking the item of motion gear and the use of high steam pressures — motion gear is an item constantly growing in weight and size, and many locomotives are being run with distorted steam distribution. That represents wastefulness. Where the steam is used unnecessarily, it means a waste, and that goes right back to the fire-box and the fuel consumption, which is a primary factor. Comparing the present gear of general type, the Stephenson, with the motion in use in foreign

countries; by applying the latter gear to our modern locomotives so far as it has developed, we have secured good results. Whether it can be satisfactorily worked out in further detail remains to be seen.

I agree that the cylinders should be bushed, and if we can get castings made of cast steel, that practice should be followed out both from the standpoint of efficiency and less liability of breakage, and also to give reduced weight. The weight which we can take out of these castings should give us more weight to put in the boiler and other parts of the engine where we can use it to better advantage. The requirements of locomotive boilers are not only to supply the steam to operate the machine, but also to drive the air pumps on long trains requiring the use of air compressors developing 50 horse-power. On passenger trains, there is the necessity for steam heating in the winter; also the operation of automatic sanders and of many other appliances which require considerable steam, in addition to what is necessary to haul the train.

As to the remarks about the narrow fire-boxes — these are very interesting to me, because in our own experience, as well as from the experience of other railroads, we have generally found that the narrow fire-boxes have resulted in the earlier cracking of the sheets than in the case of the wide fire-boxes, and our investigations have developed that it has been mainly due to the design and construction where the sheets are too rigid or the fire-box too long and the water space restricted, as well as to the method of washing out and cooling down the boilers, all tending to produce serious strains which result in the difficulty. We have renewed many fire-boxes which are only three, four, or five years old, and we attribute the difficulty in some cases to the material, in some cases to the design, and in others to lack of maintenance attention. These are factors which are involved, and can be overcome by a design to better meet local conditions. I do not think it is possible to design one type of locomotive and make use of it to advantage on numerous divisions or over a large territory; for if you take into consideration the changes in fuel, water and weather, everything counts in producing economical maintenance and operation.

In the use of narrow fire-box boilers, while it is, of course, possible to make a design which will cover all conditions, when you do that, you may restrict your tube heating surface and grate area. In our experience, we have found even where we had reduced tube heating surface but with large grate area, we could always get steam; but where we had the reverse, we did not always get steam.

**Mr. B. Dubois**, French Western Railway. (In French.) — We have heard that the cylinders of American locomotives break so often that it has been found advisable to use special kinds of metal in their manufacture. On the French railways, we have not experienced the same sort of trouble. Perhaps our American colleagues will be good enough to tell us the probable causes of these breakages of which they speak and tell us at what points they have found these breakages occur.

**Mr. J. E. Muhlfeld.** — In our experience, the breakage has been in the nature of cracks through the steam and exhaust ports and in the walls of the cylinder. Where we have followed the practice of bushing cylinders, both the cylinder proper and the bushing are made of cast iron, of practically the same quality, but the bushing on account of being separately cast will give a better bearing surface and a tougher, closer grained material than in the large casting, due to foundry practice. We have removed quite a number of cylinders on account of cracks developing through the steam and exhaust port and in the walls of the cylinder. The cracks in the walls of the cylinder are largely on account of accumulated condensation and in some cases on account of the walls having been bored out too thin, and other factors, which would be overcome if we made use of cast steel in the cylinder proper, and used cast iron bushings.

**The President.** (In French.) — If no one has anything more to say on the second conclusion, I will ask our principal secretary to read conclusions 3, 4 and 5, which we can discuss together.

**Mr. Boell,** *principal secretary* :

“ 3° Locomotives of comparatively recent construction have been built without proper consideration for the use of railroad standard designs, specifications, practices and processes, which continued experience may have determined to be more suitable and interchangeable than the standards of locomotive builders.

“ 4° The present ineffective load should be reduced by the use of design and material which will combine the least weight and greatest desired strength.

“ 5° The elimination of those individual preferences, patented devices, fads and frills which have no real value, by the use of simple, practical design and construction, will produce more satisfactory general results ”

**The President.** — **Mr. Deems**; will you give us your experience in relation to the third, fourth and fifth conclusions?

**Mr. J. F. Deems.** — **Mr. President**, I do not know that I am prepared to say much about this. I have read them very hurriedly. I note that the chapter XXI begins with the following :

When railroads must rapidly develop their locomotive stock, for the increased demands of traffic, it becomes a difficult matter to get sufficient time to make thorough investigations and tests, and to determine the most practical and advanced design, specification and method of construction that will fully meet the general requirements.

I have an impression we are meeting those difficulties on this side of the water more than they are on the other side, on account of the very violent fluctuation in the volume of business which we handle. The facts in the case are exactly as **Mr. Muhlfeld** has cited them. We have got to secure locomotives on comparatively short notice, one hundred, two hundred and three hundred, and the operating

department says they must have them as quickly as we can provide them. The locomotive people say we must reserve a space, etc., and everybody is pushed to the limit to get a locomotive, something which will move a train and the result is that the care and attention to details and design especially for a new type of locomotive, are not quite as they should be. Locomotives are purchased, and perhaps they are not satisfactory at first, and little by little they are altered and changed, and the design of the locomotive brought up to something near what it should be. I have an impression, however, that the condition described is one which is met in this country in a much more aggravated way than it is across the water, where the fluctuations in business are not so great as they are on this side. This is a very important consideration in connection with the purchase, not only of locomotives, but all types of rolling stock.

Under the head of the fifth conclusion regarding the elimination of these individual preferences, patented devices, fads and frills, which have no real value, by the use of plain, simple, practical design and construction which will produce a more satisfactory general result, I think that is a matter which should be dwelt on and given a great deal of thought. I think it is receiving such thought at the present time.

I notice on pages 60 and 61 <sup>(1)</sup> in connection with this conclusion, in the second paragraph, Mr. Muhlfeld calls the attention of railroad mechanical engineers to the importance of giving more attention to the practical uses, so to speak, of the locomotive, and cutting out the fads and frills and individual preferences. Of course, that is a little difficult. It is pretty hard to eliminate human nature and it will crop out in the design of a locomotive, but I think it is one of the things which should be given a great deal of consideration by designers, not only the engineers of the roads but by the builders. I feel, however, that perhaps not enough careful attention has been given to the design of the locomotive by the railroad mechanical engineers, and it is for the very reason which has been stated before, when the time comes to buy locomotives, they do not have the time to give the consideration to the details, the builder has the thing worked up, it is presented to the management, and the locomotive is bought.

**The President.** (In French.) — I should like to remark once again that the compound system with high pressure is a subject of high interest. Are there any engineers present who believe, on the contrary, that the simple non-compound engine is capable of proving quite satisfactory?

**Mr. D. F. Crawford.** — Our experience in compound engines is so limited that I cannot say anything about the question which has been proposed by the President.

**The President.** — Will Mr. Gibbs speak?

---

<sup>(1)</sup> Vide *Bulletin of the Railway Congress*, No. 4, March, 1905, p. 1076 et 1077.

**Mr. A. W. Gibbs.** — I would rather be excused.

**The President.** — We would like to hear from Mr. Sanderson.

**Mr. B. P. C. Sanderson.** — I dislike to say anything after Mr. Gibbs declines, but I think this is true. The compound principle of steam engines had reached its highest development in marine and stationary and pumping service, where the loads were practically uniform at all times, where the work developed in the machine was practically uniform. If you can reason from analogy, it looks as if the compound locomotive could be expected to be a permanent success on such grade lines where the work done will be practically uniform, because, if I understand it, the compound engine is not economic except within certain narrow ranges of expansion for which the cylinders are especially adapted, and if the engine is worked heavily overloaded or underloaded, a considerable portion of the time, on account of an undulating grade line, it will be more wasteful than the simple engine. From that it seems to me there is a field, and a permanent field, for the permanent success of the compound engine; and another field where the simple engine will always hold its own.

**Mr. G. B. Joughins,** Department of railways and canals of Canada. — I have had some experience with compound engines dating back for ten or twelve years. The first railway with which I was connected, where we had the compound, was a railway of light grades through a practically level country, and we found very great satisfaction in the use of the compound engine. We were always able to save a large proportion of the fuel, certainly 15 or 20 per cent. The men who ran the locomotives liked them very well, at least, after the first few months during which it was necessary for them to become acquainted with the machine, and finally they preferred the compound locomotive to the simple engine, because in that country it is able to haul a long train with less fuel and less labor on the part of the men than the simple engine. In the case of the road with which I am connected at present, however, we have on every division one per cent grades in both directions, we seem to be always climbing over a mountain and the consequence is that the compound engine is not so satisfactory for that service. During the time we are going down grade, the compound feature is, of course, not in use, we are not using steam, and the simple engine under these circumstances seems to give better service than the compound; it runs down hill easier, and therefore at the end of the journey it does not require so much repair as the compound engine. In consequence of going up the grade on one side and going down on the other, we do not find such a large economy in fuel as in the level country. The total expenses of running the locomotive are very slightly different in the two types, because while the compound engine saves a little in fuel, under these conditions it increases the maintenance account. It particularly requires more expert service and more experienced mechanics to make repairs upon it than the simple engine, and it seems to us as though we need expert

mechanics to attend to the compound engines at almost every roundhouse and every division point to make their service satisfactory. Of course, that is brought about by the fact that all the mechanics in this country have been trained to become familiar with the parts of the simple engine. If something is wrong, they immediately know where to look for the trouble and go ahead and repair it; they can soon put the engine in shape so that it can be used. But in the case of the compound engine, we find our mechanics much less familiar with it, and when an engine comes in with something wrong, it takes them a long time to find out what it is and to make it right.

**The President.** — What kind of compounds were these, two cylinders or four cylinders?

**Mr. G. R. Joughins.** — On both roads we had the same style of compound locomotives — known as the Vaucrain compound.

**The President.** — We should be glad to hear from Mr. Mitchell.

**Mr. A. E. Mitchell,** Lehigh Valley Railroad, United States. — My first experience with the compound locomotive was about fifteen years ago. At that time I was on a road where we only had a few miles of level country. We experimented with compound locomotives with the result that we did not increase the number beyond what was originally purchased; the total number on the line when I left it ten years later was something like eighty. In the West, where I had experience on roads in level countries, over the prairies, and at the same time through the mountains, we found that the cross-compound gave us very good results in the level country. Our coal was expensive, and we did effect quite a saving in fuel. We found, however, that the expense of maintenance of the compound was a great deal more than it was with the simple engine. We found further that we could obtain anywhere from 10 to 20 per cent more mileage per month with the simple engine than we could with the compound, and when we figured the earnings of the simple engines per month as compared with the compound, we found that the simple engine was earning more money for the company than was the compound. On the mountainous divisions we had engines known as "tandem" compounds. We found it impossible on these engines to keep tight joints between the high and low pressure cylinders. The steam would blow from the high pressure into the low pressure after the engine had been in service two weeks, causing serious loss in fuel as well as delays. We experienced very great difficulty in locating the blows in the cylinders, but finally evolved a scheme by which we could detect every blow, and knew what to do to find and repair the trouble.

On the road with which I am now connected we have a mountain in the middle of the district. On that mountain we are running four cylinder compounds known as the Vaucrain type. These engines are giving fairly good service, at slow speeds, but we do not find that they save any money over the simple engine. Our coal is

very cheap, and the increased cost of repairs more than covers any saving in fuel. A great deal of our traffic is in fast freight trains or trains that average from 15 to 25 miles per hour, and the simple engine is giving us the best and most economical service. In the West we found great difficulty in hiring mechanics who understood the compound engine; at least 75 per cent of the mechanics whom we employed had not had much experience with the compound, and the same is true on all roads with which I have been connected. Any mechanic who has worked in a private shop, building and repairing stationary engines, can go into a locomotive shop and do efficient work repairing a simple locomotive, but when we put the mechanics repairing the compound features of the locomotive, they are not competent, and the result is that the compound engine is usually in the roundhouse waiting attention, when it ought to be out on the road pulling freight.

**The President.** — We should be glad to hear from Mr. H. H. Vaughan of the Canadian Pacific Railway.

**Mr. H. H. Vaughan, Canadian Pacific Railway.** — On the Canadian Pacific Railway we have quite a large number of two cylinder compounds, and our experience has been almost identical with that of Mr. Joughins. On a level road where the compound is used, and a fair amount of tractive power continually needed, we can obtain a satisfactory saving. On a continuous grade, where we should work the simple engine at long cut-off, we can also get a saving with the compound; but on an undulating division, I do not think we get any particular saving from a two cylinder compound, and therefore I do not consider it would be advisable to continue their use there, as it costs slightly more to maintain them. We have, however, used in the last year a large number of the latest type of compounds that have so far proved themselves to be one of the cheapest engines to maintain in our service, and while I do not in many ways agree with the reporter that the designs have not been properly prepared on a lot of recent engines, at the same time there has been a great deal to learn about the compounds. We have, for instance, had considerable trouble with certain makes of intercepting valves, and owing to the men not being acquainted with the different mechanisms, they have caused an amount of annoyance and delay altogether greater than they should have done, in consideration of the amount of work involved in repairing the parts.

There has existed with us and I do not think we are alone, a practice of putting an engine on the road which the men are not familiar with, and leaving it to them to get familiar with it, when a thorough and more careful course of instruction in the apparatus would have avoided a great deal of the trouble. We have four or five types of compound engines, and it takes a fairly good mechanic to keep in his mind all their particularities, especially as they are liable to be called in for repairs with various reports from engineers, some accurate and some inaccurate.

I cannot help feeling, in view of our latest experience, that we need not look for any very great additional expense in the maintenance of two cylinder compounds.

Of course, we are so situated that we are unable to use what would now be called very heavy power, and therefore the two cylinder compound has been able to fulfil our requirements. Were we in the position of some of the roads using very large engines, where we could not use two cylinder compounds, I think we would consider the matter very carefully before going into any of the four cylinder types.

I do not know if I should be opening up a new subject, Mr. President, but in view of the fact that this discussion relates to compounding, I think it is interesting to state that in the last year we have, as the result of various tests, abandoned compounds experimentally in favour of superheating. We had two compound superheaters in service for quite a long time, and while our coal records were largely taken from the actual result of the service and not from any special test, our conclusions were that the compound superheater did not show any considerable gains over the simple superheater, and in view of certain advantages of the simple engine, we decided to build a fairly large number of simple superheaters in order to have sufficient of them in service to allow us to feel that they were not being favoured or condemned. When we had one engine of each type, we generally had a pretty good man assigned to it, and if the engine happened to be liked by the men, they would get a little more attached to it than to any of the other engines, and the reports are not impartial. We have now had forty, of these engines in use for six or seven months. They went through last winter, and from our coal record so far I think it would be safe to say they are showing, in view of the conditions under which they are working, a consumption of about 10 per cent less coal than the compound engine. In every other respect, they have been just as easy to operate, and they give us the same good service we have had with the simple engine. We are now going into it more extensively, and at the end of the next few months we shall have about one hundred and ten engines in service, and in the course of a few years shall be able to tell pretty well what we shall get out of superheaters in place of compounds.

I feel that outside of all other conditions, there is an advantage if economical results can be obtained in using the simple engine. The simple engine has an advantage from a traffic standpoint. It cannot be overloaded in the way a compound engine can. In order that a compound engine may develop sufficient power when compounded, it is necessary to have a high pressure cylinder a little larger than the simple cylinder that would be used on an engine of the same size. That gives the engineer an opportunity to simplify that engine, and in spite of every consideration, as long as you can by simplifying the engine and working her on sand get her over the grade, the men will not cut their trains and double, and the engine is abused in a way the simple engines is not abused, because it will stop when overloaded. It has a limit. I think the trouble with the compound is partly due to its great capacity to struggle along and handle loads it should not be asked to take, and for that reason, I think we should get better service from the simple engine, if by superheating, we can get a satisfactory coal economy. From

our experience so far, I do not think we could get sufficient economy out of compounding the superheaters to pay for the additional trouble and cost.

**The President.** (In French.) — I should like to consult the meeting as to whether we should continue the sitting. We have been sitting for three hours and it is now 12.30. Will those who are in favour of adjourning kindly hold up their hands. (*Carried unanimously.*)

— The meeting adjourned at 12.30.

---

**Meeting held on May 6, 1905 (morning).**

---

**The President.** (In French.) — I will now ask our principal secretary to be good enough to read the last conclusions of Mr. Muhlfeld's report.

**Mr. Boell, principal secretary** (In French) :

“ 6° The mechanical department supervision has often been curtailed when expansion of organization and direct mechanical control should have been given to insure the desired performance. Changes in organization and methods have frequently been effected in preference to conservative management, with instruction, education and substantial recognition for the deserving rank and file.

“ 7° The locomotive maintenance and dispatchment facilities have not always been developed to meet the proportionate increase in the locomotive dimensions, capacity and requirements, while slow line movement has made it necessary to increase average mileage by reducing terminal mechanical delay, during a period when more opportunity for maintenance and handling has been essential.

“ 8° The tonnage hauled per train has frequently precluded the making of an average speed between initial and destination terminals that would be productive of efficiency and economy in locomotive operation.

“ 9° Decreased efficiency has resulted from the irregular transferring and crewing of locomotives for long runs. The regular assignment of crews to locomotives and of suitable locomotives to shorter runs on regular districts, should accomplish the best results.

“ 10° Provision for the cleanliness and care of employees and equipment on the line and at terminals, should receive more consideration.

“ 11° Personal supervision and investigation should govern in the construction and operation of locomotives of great power, whilst statistical information and correspondence should be limited and used with caution.”

**Mr. A. Buchanan, Jr., Central Vermont Railway, United States.** — **Mr. President,** I am not prepared to speak on conclusion 6°, but I would like to say something with

respect to the discussion held yesterday, if I may have permission. I would say that the road with which I am connected has gone into the two-cylinder compound engine for freight service quite thoroughly, after quite a long observation, and we have practically come to the conclusion, on account of the prohibitive price of fuel in the territory where we are located, that the two cylinder compound has best met our requirements on account of fuel economy. We have found on our line that we have an economy in fuel of probably 10 per cent, which is considerable to us when coal is at 3.50 dollars per ton. We have also found that the cost of repairs on the compound engine increases probably about  $\frac{1}{2}$  cent per mile, and this increase is almost entirely taken up with the compound features, the intercepting valves, etc. We have also found that it is a difficult matter to get mechanics to understand the compound features and to handle the same at the roundhouses, terminals, etc., and the best results have been obtained by taking special men and breaking them in for that purpose; in other words, making specialists out of them. We have found it impossible to hire men to do that work without a special preparation, which we are able to give them. We have also found that Transportation Departments generally will give the maximum train load, so the engineers will not use the proper care on grades. They work engines in simple position too much. In other words, the engine should be worked simple only when starting trains. We have one grade which we have to watch very carefully, for if not, the engine will be worked in simple position over the entire grade. I have been led to believe that the increase in repairs has been caused on account of the careless handling of the engineers when working the engines simple. We also find that the engineers do not report the work on compound engines in an intelligent manner. They themselves do not understand it and cannot locate the defects that exist, and we have to depend to a large extent on the roundhouse staff to locate them, which of course makes considerable expense on account of their not being able to locate the defects properly at the beginning. This will of course be obviated as men become accustomed to compound feature. However, for our purpose, and for the purposes of the Grand Trunk Railway Company, which is the parent company of the Central Vermont Railway, the Mellin two-cylinder compound engine has met our expectations. The Grand Trunk road has in service something between eighty and hundred compound mogul engines, and it has been made their standard engine. We have some consolidation compounds of quite large power, weighing about 170,000 pounds on drivers, with cylinders twenty-two and a half by thirty-two and thirty-five by thirty-two, and they have met our requirements for freight service, both manifest and dead freight in every particular. If we were able to get fuel for less than 1 dollar per ton, it is a question whether we would go into compounds. It is the prohibitive price of coal that has compelled us to go into compounds.

**Mr. F. H. Clark**, Chicago, Burlington & Quincy Railway. — Mr. Chairman, the subject has been handled by Mr. Muhlfeld in a very comprehensive manner, has

included pretty nearly all the locomotive questions that we are called upon to consider; and the discussion has been very complete. With reference to conclusion 7°, I desire to say that I agree thoroughly with Mr. Muhlfeld that the question of shop and roundhouse facilities has not kept pace with the increase in the size of power. We are constantly finding that our shop-tools, some of which were bought within recent years and supposed to be large enough and heavy enough to meet our requirements for a considerable time to come, have become practically obsolete, and too light and small to properly handle the heavy equipment that we are now operating. This is also true of roundhouses and roundhouse facilities. The increase in weight and size of equipment is making a good many changes and improvements necessary. As to conclusion 8°, we find, as Mr. Muhlfeld expresses it, that the tonnage hauled has at times made it difficult to get over the road in a reasonable length of time, but we are gradually working our way out of that. We are finding what can properly be expected of our engines, and we are getting better accustomed to the use of heavier power and better able to handle the maximum tonnage, which when we first got this heavy power we could not or did not handle satisfactorily. Referring to conclusion 11°, we find that a good deal of attention to the details and to the construction of locomotives is necessary, as well as to the matter of operation in order to get satisfactory service from them. The engines we are now building are large and expensive, and we feel that it is necessary they should be kept in first class condition to properly handle the business, and that the engines should be turned with as little delay as possible in busy times. I am inclined to feel that statistics carefully and properly kept are of more value than Mr. Muhlfeld would indicate. It is a fact of course that statistics of locomotive operation have to be handled judicially and carefully, but if given proper attention, they are of very great value in helping us to operate our locomotives and to determine what changes may be desirable in the methods of operation or the construction and design of locomotives.

**Mr. A. Lovell**, Atchison, Topeka & Santa Fe Railway, United States. — Mr. President, I would like to make a few remarks on the American paper before the other papers come up. Being connected with the railroad which perhaps has more locomotives of great power and possibly more compound locomotives in its heavy classes of traffic than any other railroad in the United States, I would like to make a few remarks in relation to results that have been obtained on that system. My personal experience with compound locomotives and heavy locomotives covers a period of about ten years, in which I have had experience and made observations with the two cylinder cross-over compound, the four cylinder Vaucrain compound, the four cylinder tandem compound of both the American Locomotive Company's output and of the Baldwin Locomotive Company's manufacture. In all of these different types of locomotives, I have made a number of extensive investigations covering actual service, and I have never yet in any kind of service or any division with any of these different types of locomotives, found a case covering any extended period of time, in which the

compound locomotive did not show a decided economy in fuel as compared with the simple locomotive. The two cylinder compound is a very desirable type of engine for moderate sized power, inasmuch as it has less number of parts. There is, however, one feature which has been brought out in this discussion, viz., that the intercepting valve requires some attention, and requires the shop forces and the engineers to be well educated in the care and maintenance of the intercepting valve, to keep these engines in the same condition as a simple engine. Otherwise from the intercepting valve I fail to see any feature about a two cylinder compound engine that is any more difficult to maintain in its service than a simple engine. When I became connected with the Santa Fe system, which is nearly three years ago, they had recently secured about 140 Vaucain compound locomotives for both passenger and freight service. These were of heavy type, probably as heavy as any locomotives used in passenger service, if not heavier than had been previously built. The only difference between the freight engines and the passenger engines was in the size of the driving wheels. These engines being very much heavier than any that had been previously used on the territory where these engines were put in service, naturally created a feeling of objection among the engineers and the firemen, who thought that they would be more difficult to handle. When conditions like these exist, there will naturally be some increased cost of maintenance. This, however, will wear away as the engine crews become familiar with the performance of the heavy or great power locomotive, and the compound feature. After we had had these engines in service for something over a year, it became apparent that more passenger engines were needed, and to demonstrate beyond a doubt whether or not we were right as to the merits of the compound features, we secured twenty-six *Pacific* type passenger engines — though a part of them were of similar type for freight — with simple cylinders. They were the same type of engines as the compound type which we had been using, with the exception of the forward trucks and the cylinders, and were as nearly as possible of the same weight. A few of these engines were secured with medium sized drivers to correspond with the compound engines in freight service, and the majority of them had 79-inch drivers to compare with the compound engines in passenger service. They were put on the same territory in the same kind of service, the passenger engines hauling passenger trains in a pool with the compound engines and the freight engines were put in a pool with the compound freight engines of the same general character, with the exceptions previously noted. An accurate record was kept of the performance for a year. The record is still going on. They have been in service now about a year and a half, although the passenger engines have been transferred to another territory. The results demonstrated without a doubt that the compound engines were the most economical in fuel. The repairs were very approximately the same with the compound engines as with the simple engines. Something over a year ago it became necessary on the Santa Fe system to get additional engines for freight service on the mountain territory at the westerly end of the system. There had previous to that

time been in service two heavy Decapods, built by the American Locomotive Company, and one built by the Baldwin Locomotive Works, having approximately 234,000 pounds weight on the drivers. These engines had given such satisfactory service with one or two exceptions, that it was decided to get engines equally as heavy or heavier, if possible, but to add a trailing wheel in order that the engines might back down the grades more readily when used as helpers on mountain grades. Eighty-six of those engines were secured, one of them being a simple engine and the balance were four cylinder tandem compound. The simple engine was obtained for the same purpose previously mentioned of demonstrating to our satisfaction whether or not we were making a mistake in getting compound engines for this service. I might add that about half of these heavy engines were coal burners in a coal burning territory, in New Mexico, and the balance were oil burners in an oil burning territory in Arizona and California. The simple engine was an oil burner. It was put in service with the others on a district about 150 miles long, and in which the grade in one direction was almost a continuous uphill pull for 120 miles. The maximum grade was 95 feet per mile. It was kept in that service for two or three months. It was demonstrated that the simple engine could not handle as much freight, up to about 200 tons, as the compound engines, the distance between the water tanks not permitting the simple engine to take so much train without running for water, while the compound engines could make the run with full tonnage between the water stations without any difficulty. It was further demonstrated that the compound engines could handle more tonnage on a maximum long pull, because the steam pressure could be more efficiently maintained than with the simple engine. The engine was transferred to another district of approximately the same length in Arizona, in which the maximum grade was 137 feet to the mile, the engine running through over the entire district but having helpers over the maximum grade, which was perhaps during the length of 10 or 12 miles. The engine was here also kept in service with the compounds of the same type. Our engineer of tests and his assistants kept records of the performance, during a period of sixty days measuring accurately the water and the oil used. In addition, an accurate record of the performance in regular service was continued. The results demonstrated in both cases that there was an economy in the fuel consumption of between 20 and 25 per cent with the compound engines as compared with the simple engines. As to repairs in this particular instance, the simple engine was very much in excess of the compounds, and was in the shop very much more than the average of the compounds, the reason for this being that in oil burning service, the steam requirements are such that the fuel is burned very rapidly and the action on the fire-box is very severe. The simple engine had to have its fire forced harder than the compound. The result was that the fire-box developed defects, the flues leaked, whereas it was finally necessary to take the door sheet out of the fire-box and renew it before the tests were completed. It is of course unfortunate that we have but one of these simple engines, as it may be said that the

extraordinary repairs were an accidental occurrence. Be that as it may, it is certain that more heat must be developed with a simple engine to evaporate more water; in order to get more steam to haul equal tonnage with the compound. This must necessarily be harder on the fire-box and the flues, which is one of the greatest troubles in oil burning engines, and the trouble in this case was materially aggravated by the simple cylinders. With regard to repairs of heavy locomotives and compound locomotives in general, the statement was made in yesterday's meeting by a number of speakers, I think, that the repairs on a compound engine were so much more than on simple engines that the cost counteracted any benefits in economy that might be derived by compound features. My experience has been that ordinarily where the engines are of equal weight and in the same kind of service, there is but little difference in the repairs. I believe that any additional cost of repairs is in almost every case due to the large and heavy type of engines which we are securing of late years as compared with the lighter engines which were formerly used. We are having, without question, on most railroads, and particularly on our own, an increased cost of repairs per engine. Our engines are very much heavier than formerly. When the repairs are compared per ton and mile of freight haul, the difference is not so great, and in some cases, I find it is less than with the lighter and simple engine.

I think Mr. Deems yesterday questioned the desirability of going into the *Atlantic* type or rather balanced compound engines, on account of the danger of breaking the crank axle. He seemed to think that this feature had yet to be demonstrated. The Santa Fe system secured a little over a year ago four *Atlantic* type balanced compound engines. They were put in passenger service on a comparatively level grade division for nearly a year and rendered exceedingly economical results. They did, however, develop a good deal of heating on the cranks. It was some time before it was discovered what the trouble was. It was afterwards found that the heating was caused by an insufficient lateral clearance in the brasses of the cranks. When this was relieved there was no further trouble and the engines are running to-day as cool as any engines we have on the system. Before the cause of the trouble was discovered, however, I think three of the crank axles developed cracks, which in my opinion was caused by the heating and cooling of the axles and for the reason previously stated. One of those axles was renewed by a new one. I will say that these axles referred to were solid forged axles made in Germany. I think two of the other axles were drilled through the crank pin, and a pin  $4\frac{1}{2}$  inches in diameter of the toughest iron obtainable was forced in. Those axles are still running. The crack has not extended and they are giving good service. The results of those four engines were so desirable that the company secured later fifty-three more *Atlantic* balanced compounds, and have recently placed an order for fifteen more of the same type and also thirty *Pacific* type balanced compounds. I believe that the compound engine of great power has come to stay. I believe that a few years hence anyone who builds a heavy type of locomotive with simple cylinders will be looked

at in the same light as would a man who should design a simple engine to take an *Atlantic* liner from New York to Liverpool. (*Applause.*)

**The President.** (In French.) — I will now ask Mr. Boell to read the conclusions of my report and then we will continue the discussion on the whole group of conclusions.

**Mr. Boell, principal secretary.** — The following are these conclusions :

a) *Wheel loads.* — An important point in considering locomotives of great power is the wheel load permissible. Most of the lines of any importance allow at least 7·5 English tons; frequently the limit is 8·5 to 9 tons. It is 10 English tons on several English railways; in the United States, there are instances where higher wheel loads are admitted. If we limit ourselves to the continent, wheel loads hardly exceed 9 tons (8·86 English tons). But it is probable that the traffic of trunk lines will require a new increase in the power of locomotives for fast trains, so that it will be desirable to have tracks which can stand wheel loads of 10 tons (9·84 English tons). However, in order not to fatigue the rails too much, it might be specified that this limit of 10 tons (9·84 English tons) is only allowed in the case of locomotives constructed so as to keep within sufficiently narrow limits, at the highest speeds, the variations of load which are produced at each revolution of the wheels.

b) *Gauge of the tracks.* — The power of locomotives built for tracks of wider gauge than the standard, which are used in some countries (Spain, Portugal, Ireland, Empire of India, Russia) does not exceed that of locomotives running on standard gauge tracks. In order to benefit by the wider gauge, it would be necessary for the track to stand heavier wheel loads.

c) *Diameter of driving wheels.* — The diameter of the wheels hardly exceeds 2 metres (6 ft. 6  $\frac{3}{4}$  in.) with the fastest locomotives; at most it amounts to 2·10 or 2·15 metres (6 ft. 10  $\frac{11}{16}$  in. or 7 ft.  $\frac{5}{8}$  in.). Very high speed locomotives often have wheels of a less diameter than 2 metres (6 ft. 6  $\frac{3}{4}$  in.). This results in more than three hundred revolutions per minute (this corresponds to a speed of 113 kilometres [70·2 miles] per hour with 2 metre [6 ft. 6  $\frac{3}{4}$  in.] wheels). It would be desirable not to exceed this limit, in order not to have too much wire-drawing of steam; but the disadvantages of large wheels are too great nowadays. There would be an excessive increase in the weight of the locomotives and in the weight not carried on springs, and it would be necessary, as in the old locomotives, to reduce the diameter of the boilers. The disadvantages of great angular speeds is counteracted by giving large cross-sections to the steam passages, particularly by using piston valves.

On the other hand, with locomotives having six or eight coupled wheels, very small diameters are not used; the diameter is hardly ever less than 1·40 metre (4 ft. 7  $\frac{1}{8}$  in.).

d) *Material used.* — The tendency is to use metals of good commercial quality; the use of exceptional qualities, *e. g.*, of nickel steel, is very exceptional and does not appear to be extending. The applications of steel castings are becoming more and more numerous and varied.

e) *Boilers.* — In the case of boilers, a grate area of 3 square metres (32·29 square feet), with a heating surface of 75 to 80 times the size, is obtained by the usual construction, with narrow fire-box. It appears to be difficult to obtain a much larger grate area on this plan, and this leads to the use of fire-boxes extending over the wheels. The large diameter wheels of the high speed locomotives must then be below the barrel of the boiler; this can be done in the case of the *Atlantic* type. In Europe, several applications of these extended fire-boxes now begin to be seen, and it is probable they will multiply. For a long time, hesitation was shown in placing the grate

above an axle, particularly in England; now, that position of the grate is generally accepted. No doubt the same will happen with regard to the extension of the fire-box above the wheels.

Very high pressures (14 to 16 kilograms per square centimetre [199 to 228 pounds per square inch]) are used at present, particularly with compounds. They necessarily involve an increased cost of maintenance of the boilers.

Serve ribbed tubes are generally used, particularly in France; they are useful by making it possible to have a larger heating surface with a boiler of given size. The tubes must be cleaned out frequently and with care.

f, *Compound system*. — As a general rule, it is well established that the compound system results either in a certain economy of fuel for the same power, or more frequently in an increased power for the same fuel consumption. In some few cases, these advantages have not been realized; this may depend on the particular use made of the locomotives or to some defects in the application of the system.

The use of four separate cylinders, acting by twos on cranks placed at  $180^\circ$  to each other, makes it possible to obtain greater power without fatiguing the mechanism too much; this arrangement balances the reciprocating masses, without producing vertical disturbances. As far as possible, the cylinders must act on two different axles, but these are coupled up.

It is advisable that each system should have a valve gear of its own, and that it should be possible to operate independently the reversing shafts belonging to the two groups of cylinders, high pressure and low pressure.

g, *Valve gear*. — No mechanism has succeeded in replacing the valve gear consisting of a slide valve and link motion. The link motions most generally used are Stephenson's and Walschaerts'. Valve gear without eccentrics has the disadvantage of being disturbed by vertical displacement of the axles.

The only modification of these ancient systems, at all common, is the replacement of flat slide valves by piston valves, which reduce friction, and consequently wear, and make it possible to arrange larger passages for the steam. On the other hand, a piston valve may leak; it makes it absolutely necessary to have a valve for admitting air to the valve chest for running with regulator closed, and it is advisable to fit relief valves on the cylinder ends.

h) *Motion*. — Tail rods are to be recommended as soon as the diameter of the cylinders attains or exceeds 500 millimetres (1 ft. 7  $\frac{21}{32}$  in.). The lubrication of the slide valves and pistons is ensured in a continuous manner by lubricator pumps or by sight feed lubricators, placed under the eyes of the crew.

i) *Power of locomotives*. — With the present limits of weight admitted on the main European systems, locomotives can be built, thanks to the use of high pressures and the compound system, giving 1,500 to 2,000 indicated horse-power (1,480 to 1,973 indicated British horse-power).

j) *Locomotives for high speed trains*. — For heavily loaded high speed trains, locomotives of the Atlantic type or locomotives with six large coupled wheels are used. The choice between the two types depends on the nature of the service, on the profile of the lines, and also on the maximum wheel load allowed.

k) *Locomotives for general purposes*. — The locomotive with six coupled wheels and bogie, the wheels having a diameter of 1.5 to 1.8 metre (4 ft. 11 in. to 5 ft. 10  $\frac{7}{8}$  in.), is eminently suitable for a passenger train service, and the same locomotive can also haul goods trains satisfactorily.

l) *Locomotives for heavy goods trains*. — For heavy goods trains, there is a return to locomotives with eight coupled wheels, by preference with a leading pair of carrying wheels. These

locomotives can exercise tractive efforts of more than 10,000 kilograms (22,000 pounds); they are limited by the strength of the couplings used in Europe.

m) *Tank locomotives.* — A very fair amount of attention is being paid to the design of tank locomotives with six or seven eight coupled wheels, either for suburban train services, where very quick starting is necessary, or for very long distance runs. A leading pair of wheels or bogie is added either at one end, or at both, according to the nature of the service. Having two bogies, however, results in having very long and very heavy locomotives.

For the convenience of the service, these locomotives have long foot-plates for the crew, and carry large quantities of water and particularly of fuel, at least as much as is carried in the small separate tenders which are still in use.

n) *Locomotives with flexible wheelbase.* — The only type of powerful locomotive with its whole weight adhesive and arranged to run over specially sharp curves, which is largely used, is the Mallet type. However, most railways content themselves with locomotives of the ordinary types, without flexible wheelbase.

o) *General remarks.* — The railway industry does not escape a law to which nearly all industries are subject, owing to the rapid progress made in engineering, of almost continuously modifying its stock. As soon as new locomotives have been designed, which are very superior to those used previously, one is tempted to think that to some extent finality has been reached, or at least that during a sufficiently long period it will be possible to do without any new designs. It appears very tempting to keep for a long time to standard types, which are cheaper to build and easier to maintain; but progress, which does not stop, hardly allows definite types to be determined.

Thus on European railways, we find locomotives running developing 1,500 and even more indicated horse-power (1,480 and even more indicated British horse-power); but the continual increase in train weights and train speeds makes it necessary to day to look for still more powerful locomotives, if not for actually existing needs, then at least for the needs of the immediate future.

But the old stock need not, therefore, be given up entirely, and the variety of existing railway services makes it possible to utilise locomotives well which are already of older date, but care must be taken that the unavoidable age of such locomotives, which is the result of the efflux of time, is not increased by an artificial age, by making them several years old already when building them.

**Mr. Moffre, Midi Railway of France. (In French.)** — Gentlemen, the eminent engineers who spoke yesterday on this question of locomotives of great power, have explained to you why compound engines have met with little success in America. It is acknowledged that these engines mean a saving of fuel estimated at 10 per cent, which is compensated for by a considerable increase in expenditure on maintenance to which these engines give rise.

In France and in some neighbouring countries, especially in Spain and Portugal we are of a totally different opinion, so much so that almost all the engines built of late years are four cylinder compound balanced. We find a saving of more than 10 per cent in fuel, and this saving is nearer the 25 per cent mentioned by the Santa Fe engineer.

It is rather difficult to draw any accurate comparisons, because it is very seldom that we have simple and compound locomotives doing precisely the same kind of

work. But on the Midi of France, we have some engines fulfilling these conditions. We have converted some old high speed locomotives with a steam pressure of 12 kilograms (170.67 lb. per square inch), into two cylinder compounds. At the end of a year, we found that the consumption of coal had fallen about 20 per cent. In France, where we are not lucky enough to be able to get fuel at the very low price that is prevalent throughout a large part of the United States, we cannot afford to ignore so large a saving. Speaking generally, I estimate the fuel saved by using compound engines at 18 per cent.

But this is not the only question arising from the use of engines of great power. In France, we attach much importance to having four balanced cylinders. This arrangement by subdividing the strains over twice as many parts, by making it possible to balance so to speak completely the reciprocating parts, has made it easy to build locomotives of very great power which we need, not only for fast passenger trains but also for very heavy goods trains. We have been able to build these engines without using excessively heavy parts which would have been very disadvantageous for running at high speeds. Accordingly four balanced cylinders have been generally adopted, not only for express engines of the *Atlantic* type, but also for engines hauling ordinary trains. These engines have six coupled wheels and goods engines of the *Consolidation* type.

As regards the inconveniences advanced against compound engines of French pattern, the first, and the one which appears to concern you most, is that which arises from the necessity of using crank axles.

In Europe, this question is, so to speak, dead. We all have now-a-days whole series of out of date engines whose crank axles have stood mileages exceeding 600,000 kilometres (373,000 miles). On the Midi Railway, we have been running for the last eight years a whole series of twenty-four engines of the American pattern, of which not one axle has yet been taken out. All the other French companies are in a similar position in this respect and, mind you, I am now speaking of axles made of ordinary steel years ago. Now-a-days metallurgical science can provide us with nickel-steel or superior steel from which we should hope to get much longer mileage. Accordingly I am convinced that no American engineer will be put off by the fear which now seems to be generated by crank axles.

As regards the repairs required by four cylinder engines, a distinction must be drawn between repairs of parts and boiler repairs. Obviously the fact of having to maintain a larger number of parts seems bound to increase the number of repairs in the working parts; this in fact does increase them, but by no means doubles them. According to our experience the increase is about 40 per cent. On mountainous railways, where simple expansion engines suffer severely we have even found that compound engines cost less to maintain despite the increased number of parts.

Boilers and steam appliances likewise involve an increase in maintenance expenses. This increase is due not so much to the compound system, but to the

fact that the steam pressure is 13 or 16 kilograms per square centimetre (213 or 227·5 lb. per square inch), whereas it was only 12 kilograms (170·67 lb.) before. Increase in cost of maintenance is not, however, considerable, and I hope we shall succeed in avoiding the extra expense either by using more suitable shapes of boilers, or by altering the shape or substance of the stays. In any case, we have no reason to regret adopting the compound system. Increased cost of maintenance is far from counterbalancing the saving realized on fuel.

The use of four cylinders has given us advantages which we consider of prime importance, so much so, that if the compound system were now to be given up and replaced either by super-heating or by returning to the simple expansion engine, I am convinced that almost all French engineers would continue, despite everything, to use four cylinders.

**Mr. W. McIntosh.** — Mr. President, some ten years or more ago that eminent engineer of world wide fame, Mr. M. N. Forney, remarked before the Master Mechanics Convention that point for point and dollar for dollar he would build a simple engine that would render as efficient service as the compound engines that was then the prevailing type in this country. I believe the results for the past ten years have verified Mr. Forney's claim. This does not necessarily condemn the compound form which has been so successfully applied in stationary and marine practice, and in some isolated cases in railroad service. This is an age of improvement and the world moves on, and because the earlier types of compound failed to meet the expectations, there is no reason to condemn the principle entirely, and we look forward to improvements. It is evident from what a number of the gentlemen have given as their experience, that improvements are already developing. There is, however, some limitation to the successful application of the compound principle on locomotives. You are limited by both space and weight. With reference to the simple engine, I have no fear of being nailed to the cross and placed in the back ranks, as our eminent friend, Mr. Lovell suggests, if I do not take up the compound principle, because I believe that by making the most of the simple engine, giving it good care or in the first place developing it well and then caring for it properly, it will render efficient service for a number of years to come.

**Mr. Karl Steinbiss,** German Government. (In German and in English.) — Mr. President and gentlemen, I should like to give you a short report about the experience we had with compound locomotives in German countries. For twenty years, compound engines have been designed and constructed in Germany of different kinds and systems. In the beginning there were some difficulties, but those difficulties were overcome by improvements in design of locomotives, especially as to the starting parts, by special information and instruction given to the engineers, and by good methods in the shops. For fifteen years, compound engines have been used more and more in Germany. More than five thousand of them are now in use with full success in passenger service at low and high speed and in freight train service

with light and heavy loads, with two, three and four cylinders, balanced or otherwise, without any trouble. The repairs are usually not much more than with simple engines, especially since we have changed the starting parts. They are about 40 per cent more. I might say that the performance of these engines both in passenger and freight train service, over all kinds of tracks, level and grade, has been quite satisfactory. We have given special consideration to the improvement of compound engines, because coals are much more expensive in Germany than in the United States. The price of coal in Germany averages 15 marks a ton (18s. 3d. per English ton). We also use superheated steam. We are now experimenting with locomotives on that system. We have used the superheated steam system of Schmidt and also that of Garbe. We hope to get by this improvement an application of superheated steam in simple engines and thereby to make some progress. Superheated steam in connection with the piston valves and a good balance, has given until now very good results. I am sorry that I cannot give you the correct figures, but I ought to mention that Mr. Garbe, one of the experimenters with superheated steam locomotives, will publish a report next year from which you may obtain good results. Of course we cannot approach the heavy locomotives of America, because in Germany we are strictly limited in our wheel loads. The law does not allow us to exceed 8 tons per wheel and in special cases 9 tons, whereas the American constructors may employ 12 or 12  $\frac{1}{2}$  tons, and I have seen locomotives of this kind working with success.

**Mr. A. W. Gibbs.** — Mr. President, I have had some opportunities of studying the construction of the four cylinder compound engines as constructed in France from the designs of Mr. du Bousquet and Mr. de Glehn, but before entering into a discussion of the details of construction, I desire to call the attention of some of my American colleagues to the figures in Mr. Sauvage's report. On page 29 <sup>(1)</sup> are some figures concerning the use of these engines on the Northern Railway of France. If you will look at the total weight of these engines, you will see that as we consider engines, they are very light. It is unfortunate that Mr. Sauvage did not give with his paper the profile of the line between Paris and Calais, but in brief, it starts from Paris for about 13 miles with grades of  $\frac{1}{2}$  per cent having very short levels interspersed. In one of his previous papers, were given some complete diagrams of that road, and on this stretch of  $\frac{1}{2}$  per cent there was a maintained speed of about 52 miles an hour, with a little under 300 metric tons (295 English tons). Now, this engine weighs about 140,000 pounds. Have we any engines in America of that weight that will beat that performance? I very much doubt it.

I obtained permission from our management to order one of the French four cylinder compounds, which was ordered after communication with Mr. de Glehn. I asked that the engine should be the largest of which the design permitted, but

---

<sup>(1)</sup> Vide *Bulletin of the Railway Congress*, No. 12, December, 1904, p. 1664.

Mr. de Glehn was not able to give the largest locomotive that it is possible to construct on this design, because it would be necessary to work up new drawings, which he was not then prepared to do. If you will notice the dimensions given in Mr. Sauvage's paper, all of these four cylinder compounds have cylinders within quite narrow limits. You will see that the cylinders range in the high pressure from a little over 13 inches to a fraction over 14 inches, and the low pressure cylinders to not over  $23\frac{5}{8}$  inches, the limitation being that of the two low pressure cylinders that may be placed between the frames. Mr. de Glehn explained that if necessary he would place the low pressure cylinders outside. Now, the largest engines mentioned by Mr. Sauvage are low pressure cylinders of twenty-three five-eighths, so that apparently while the low pressure cylinders are maintained between the frames, there is a limit to the cylinder power of the locomotive. Now, as to the construction of the locomotive itself. This locomotive came to America and was put together. I think it would be worth a careful study by any American engineer. There is a refinement, in cutting down the weights to a minimum. The detail construction is beautiful. The frame construction and the attachment of the boiler to the frame is worth the attention of any of our engineers. The valve motion in particular is a beautiful sample of light work. Mr. Muhlfeld has alluded to the evils of the heavy valve motion. I entirely agree with Mr. Muhlfeld in his remarks that one of the greatest evils of the American locomotive, is that we have resorted to such excessive weights in our valve motion. If you contrast our heavy construction with the lightness of construction that Mr. de Glehn has used, I do not think that anybody can be long in making a choice.

As for the steam distribution of the gear used in France as compared with our own, I presume that there is no great difference; but between a valve motion which, from its construction, will not wear out or break down, and one that from its own inertia is subject to both excessive wear and breakage, there is little choice. Now, as to the performance of the locomotive in France as compared with the locomotive in this country: while I was in communication with Mr. de Glehn, I obtained permission to send one of our best engineers to France. Mr. de Glehn and Mr. du Bousquet gave him every facility for seeing the performance. The man when he came back endorsed the statements of the performance of these engines in France, but he also stated that they had a class of intelligent care from the engineers that we seldom give to our own engines. Among other things, he brought back the system of premiums paid. In brief, the wages paid were not large, but the premiums paid for coal saved, for time made up and I think for oil saved and the penalties for excessive consumption and the penalties for loss of time were all included, and although the limits on which the coal premium was based were narrow ones, the men seemed to be making considerable total wages, largely derived from their premiums. Unfortunately we have in this country, so far as I know, no system of combined premiums for good work and penalties for bad work, so that with us when a man sees that he is not going to get any premium, there is no reason

why he should try to do well. The de Glehn has been in this country something over a year, nearly six months of that time at St. Louis. There are various troubles that we have had that are partly due to our own inexperience. Among the troubles, we have had much with the copper stays breaking. We have had some trouble from the heating of parts, as we are not experienced with the system of lubrication used throughout that engine. My observation has been that the accessibility of the boxes for lubrication is not what could be desired. We are now using waste in this engine and I understand in France they use lubricating pads. We have not ventured to use the lubricating pads, because we had a little unpleasant experience with them. I would ask some of the French engineers to express an opinion as to the merits of lubricating by pad as compared with lubricating by waste. I would like to ask some of the French engineers to express an opinion as to the merits of the different kind of crank axles, that is to say, the kind with circular discs, and also the type of crank with the diagonal bar, and furnished to various locomotives, possibly the Saxon locomotive, and possibly the locomotives of the *Société alsacienne de constructions mécaniques*. The engine has a remarkable starting quality. The weight on the drivers is very low for us, about 80,000 pounds, and it is notable that the engine very seldom takes any slack in starting, starting both as a simple engine on all four cylinders. If any my colleagues come to Altoona I shall be very glad to afford facility for an examination.

**Mr. Laurent.** (In French.) — I have no wish to prolong this discussion about the views of French engineers as regards four cylinder compounds, seeing that my friend Mr. Moffre has just expressed so clearly what is the universal opinion of my countrymen.

The Northern, Paris-Lyons-Mediterranean and Midi Railways have used compound locomotives for nearly fifteen years. It is only for the last five years that the Orleans Company has owned four cylinder locomotives. It was the last company to adopt engines of this type. It pronounces itself perfectly satisfied with them, it is continuing regularly to order engines on that system, and it has every intention of adhering to compounds in future orders.

Being the latest comers, we naturally have the latest and most powerful type. The *Atlantic* engine supplied by the Société alsacienne to the Pennsylvania Railroad of which Mr. Gibbs has just spoken, was built to the design supplied by the Orleans Company.

We have locomotives of the same type with similar boilers and similar cylinders but with ten wheels; we have moreover, for goods traffic, on the very undulating lines in the centre of France, engines of the *Consolidation* type but with the same boilers and practically the same cylinders.

A word now in reply to the demand for information by Mr. Gibbs who has just told us of the trouble he has had with stays. We have likewise had difficulties of the same kind. To meet them we have replaced the copper stays in the upper part

of the fire-box with stays of bronze manganese and we are still looking for some more suitable metal.

I may, however, say that the troubles in the matter of stays are not inherent in the compound system nor even in the pattern of boiler, for we have had similar troubles with an engine of an absolutely different pattern, namely an American engine.

For five years we have been using some thirty Baldwin engines, with ten wheels, which we ordered so as to study closely American methods of building.

This investigation has induced us to apply on our own engines a few interesting details which have given us complete satisfaction.

We have had the same troubles with the copper stays on the American engines, as with our other high pressure engines. We regard them as inherent to the use of high pressures. There is, however, compensation in the many advantages.

As regards hot boxes, Mr. Gibbs asked a question which I am happy to be able to answer, thanks to experience gained on the Orleans Company. We have adopted a system of lubrication practically identical with the American, and we use the same oils as those supplied to the American railways. In our boxes, we have tried to adopt the system of lubrication with cotton waste on the American pattern. In order to compare the consumption of oil required by the two systems of lubrication, we have made tests on a fairly large number of locomotives.

From the standpoint of consumption, the American system has shown no advantage over the old method with grease pads. We have had several cases of heating with the American system, and we have decided that it would be better to go back to the old method. Since we have given up the American system, we have not had the slightest trouble either with the driving wheels or with the others.

In reply to Mr. Gibbs, I may say then that for our engines and with the same oils as the American, we distinctly prefer lubrication with pads to the system of lubricating with wicks.

As I am on my legs, I should like to add a few words on some very interesting remarks to which we have been listening.

Yesterday there was rather a long discussion as to the future use of a mechanical stoker.

In our latest engines with 3.40 metres (10 ft. 2 in.) of fire-box, we seriously considered the question of stoking and at the same time the likelihood of the fireman becoming exhausted. We attempted to settle the problem by utilising the grate area properly. Our grate bars are inclined at about 18°. Experience has confirmed our view that with this slope in stoking the fireman had only to take the coal behind him with a shovel and throw it to the back of the fire-box. The fuel then spreads over the grate without any difficulty.

In these locomotives, we manage to consume 550 kilograms of coal per square metre (112.6 lb. per square foot) of grate per hour, *i. e.*, about 1.8 ton per hour without any difficulty or exhaustion to the fireman and without being obliged to select firemen specially for the job.

A second point that struck me in the expression of the various views offered here was that objections were raised to the compound on the ground of its lack of elasticity — in other words, that these engines are not economical when the weight behind them is too small.

This is directly opposed to the extremely accurate tests we have made on the Orleans Company. We found that with a load differing by 30 per cent on the same train the consumption of fuel per unit of work did not vary more than 5 per cent. So then these engines have been found very elastic and exceedingly economical under very various conditions of working.

**The President.** (In French.) — Perhaps Mr. Asselin of the French Northern Railway could reply to Mr. Gibbs on the subject of crank axles.

**Mr. Asselin,** French Northern Railway. (In French.) — I should like first to say something about the stays of compound engines.

On the Northern of France, we have gone still further than the Orleans Company. We have replaced every one of our copper stays by bronze manganese stays, even those at the bottom in contact with the fire. It is true that the heads of these stays wear out more quickly in contact with the flame than copper stays, but we no longer have trouble with stays breaking on the road. When we lay up an engine for purposes of maintenance we take out every stay if its head is worn. Consequently, we never need lay up an engine that is at work.

As regards the hot boxes of which Mr. Gibbs spoke, we did at the outset have some difficulties with the fifth axle when we introduced the *Atlantic* engines on our lines. But these difficulties were easily overcome as soon as we made it possible for our drivers to oil the boxes of the fifth pair of wheels more carefully.

One of the great advantages we have derived from introducing compound engines, is the almost entire abolition of breakdowns on the road owing to the mechanism failing. The four cylinder compound acts, as it were, as its own reserve. If the mechanism of the L. P. cylinders goes wrong, the engine can be run with the H. P. cylinders alone or inversely with the L. P. cylinders alone if the H. P. cylinders give way.

As regards the replacement of the driving axles, I may say that the mileage we get out of them on the Northern of France is perfectly satisfactory. The two patterns of axles, the Worsdell and those with oblique bodies, are used by us and both have given us equal satisfaction. We have some driving axles on four cylinder compounds that have run 800,000 kilometres (497,000 miles) but I may add that our crank axles are made of gun metal tempered in oil.

**Mr. R. Dubois.** (In French.) — We have tried three different kinds of crank axles. There has been nothing much to choose between any of them. In selecting the pattern of axle, we could, therefore, only be guided by the cost and, in the end, we ordered parallel crank axles.

**Mr. Bowman Malcolm**, Midland Railway, Northern Counties Committee, Ireland.

— **Mr. Chairman**, I have no intention of entering into a discussion of the two very interesting papers on great power locomotives, as my experience has been principally with engines of moderate power, but as the question seems to have developed into one of the merits and demerits of the compound, and as no one from the British Isles has spoken with regard to compounds, and I am one of the few who have adopted them, you will perhaps be interested to hear my experience in Ireland. Fifteen years ago, I was instructed to build four engines, two cylinder compound engines, to be exact duplicates of our then standard passenger engine. That is to say, the engines were a duplicate in every particular with the exception of the cylinders and valve motion, and with the exception of the pressure of the compound, which was to be 170, as compared with 150 of the simple. We made very careful experiments. These engines did work exactly similar to the simple engines, and we kept very accurate account of the work done, the cost of working, the cost of coal, oil, stores, etc., and the cost of maintenance. After going on for a considerable time the experiments proved so highly satisfactory that the Northern Counties Railway, prior to its amalgamation with the Midland, decided to have that type of engine extended, and since that time they have had no other type. All these engines have been double-crewed and have done the work and have effected a saving of about 40 per cent in coal, which is a very important matter where coal is expensive. Our coal runs from 17 to 18 shillings per ton. A very accurate account has been kept during fifteen years of the cost of repairs, and I cannot find that there is any additional cost in maintaining the compounds as compared with the simple engines. It is difficult to see why there should be. They are two cylinder engines, there are no additional parts, and there is no reason why there should be any more frequent failures or need for repairs and as a matter of fact the repairs have not cost more.

Several of the speakers yesterday spoke about the additional cost of maintaining a compound engine, many of them attributing that cost to the additional complication, and to the fact that the mechanics did not understand the compound and experienced difficulty in locating the source of the trouble. Well, I do not think that is a reason to give against the adoption of the compound, because that would mean that no improvement of a radical nature should ever be adopted, simply because the men would have to be taught their business. That is a thing that time will cure. Another gentleman, Mr. Deems I think, stated that the question of economy in coal was practically nothing as compared with the importance of getting your trains run on time. Of course all locomotive men will acknowledge that the importance of running your trains on time is great, and it is the object we all aim at; nevertheless, if you can economize and at the same time not lose efficiency, surely we should not lose sight of the question of economy.

I should mention perhaps that in Ireland the gauge is five foot three, whereas in England and America it is four feet eight and a half, and the result is that in Ireland

we can build a much more powerful inside cylinder engine than it is possible to build in England or America. In England, if we want to build a bigger two cylinder engine, which requires larger cylinders, they cannot be got between the frames for want of room, and they cannot be put outside for want of clearance. The result is that if more powerful compound engines are to be adopted in England, there is no alternative but to go to the three or four cylinder type. My own opinion is that the four cylinder balanced type is the type of the future. As a proof of the economy of the engines, I may state the compound engines frequently — daily I may say — pass water stations at which the simple engines have to stop, although the tenders are the same and the work done is identical. If you do not evaporate the water, you do not burn the coal. I think that is a pretty fair proof.

The Midland Company at Derby have lately constructed a number of three cylinder compounds, having one high pressure cylinder between the frames, and two low pressure one at each side, all driving on the same axle. These engines have been worked for some time, and I believe have given most unbounded satisfaction. I am not in a position to give you any figures in regard to them. I can only add that so far as my experience goes, the compound principle is, as some gentleman to day said, come to stay. I think we shall all arrive at that conclusion eventually.

It has been suggested that the members might like to know something about our roads. The road is not what you would call a heavy road. It is undulating. We have gradients on the main line but I do not think anything worse than one in ninety. On the branches, we have one in sixty-five, and on our narrow gauge we have two long gradients of one in thirty-nine.

**Mr. A. Lovell.** — Mr. President, I desire to ask for a little information in regard to crank axles. Probably some of these gentlemen from France can state which kind of crank axles appear to give the most desirable service, whether it be the solid forged axle or whether it be a built up axle with the crank pin pressed in. Of the fifty-seven *Atlantic* type balanced compounds which the Santa Fe system has, there are about twenty-five, I think with built up axles, with the crank pins pressed in; but with the engines, none of these axles, with the exception of the first four which have been in service something over two years (and most of the others have been in service over a year), there have been no cracks or failures whatever, either with the solid forged axles, or the built up axles, and I desire to ascertain whether there is any preference in France or England with regard to that feature.

**The President.** (In French.) — I think we might now break off the discussion. Obviously it might last longer with advantage, but we ought not to neglect the other subjects propounded for our investigation. We must, therefore, finish the subject of locomotives of great power this afternoon.

I must, therefore, ask you to speak this afternoon as much but as concisely as possible, and about this there should be no difficulty, considering that the audience is one which will not misunderstand brevity.

We must therefore terminate the discussion this afternoon.

— The meeting adjourned at 12.30.

---

**Meeting held on May 6, 1905 (afternoon).**

---

**The President.** (In French.) — We shall now resume the discussion on the two reports regarding locomotives of high power.

**Mr. F. G. Wright.** — Mr. President and gentlemen, it may interest the members present if I give you a short history of our experience with compound locomotives. About twenty years ago, we built for the Great Western Railway two compound locomotives. They were built on the tandem principle, four cylinders compound. The first was built with a through piston rod coupling the high and low pressure pistons together with an intermediate gland, packed from the outside. They had cylinders 15 inches in diameter in the high pressure and 23 inches in the low pressure; in one case, 14 and 22, in the other 21 inches stroke, 180 pounds pressure, four wheels coupled, 7 feet in diameter. Another engine was built of the same dimensions with the exception that, instead of having a through piston rod coupling the two pistons together, we had a central piston rod for the high pressure cylinder and two pistons rods for the low pressure cylinder passing on either side of the high pressure cylinder, so as to get rid of the trouble with the centre gland. These compounds were run for several trips and were constantly in trouble due to the difficulty of getting the water away from both the high and low pressure cylinders on the inside. Mr. Dean, who designed the engines, made no provision for getting the water away, with the result that almost each time they went out they came home with broken piston heads. To save the expense of redesigning the cylinders, the compounds were abandoned. We had no luck with them, and when the next engines were designed, Mr. Dean went back to the simple engine.

About two years ago Mr. Churchward, who is now our chief, having heard that the de Glehn compound was the finest engine built, recommended the directors to purchase one, so that we could see what the de Glehn compound could do as compared with the simple engine. One de Glehn compound was delivered in time for the summer service which commenced on the 1<sup>st</sup> of July last, and the compound engine, which you all know about without my going into any details, ran the first train from Paddington to Plymouth without a stop, a distance of 246 miles, having made the run without a stop, and this engine was still running on that schedule when I left home on the 23<sup>rd</sup> of April. The greatest trouble with the de Glehn compound has been with the boiler, but I can endorse every word which Mr. Gibbs told us this morning in regard to this engine. The one great trouble, however, as

I have mentioned, was with the stays of the boiler of the French compound, and I venture to think it is due to the stays being too small in diameter. The boiler is pressed to 227 pounds to the square inch, and the copper stays are only  $\frac{7}{8}$  inch in diameter. For the same pressure boiler, we are using stays 1 inch in diameter closer together than they are on the de Glehn compound. With the exception of taking the boiler off the frames to renew these stays, I may say that these are practically the only repairs we have had to make. We have had a hot axle on the bogie, and some little trouble with the piston rings of the high pressure cylinder, but they were repairs which would be incidental to almost any class of engine.

At the time we purchased the de Glehn compound, we built an engine ourselves — I will not say to compete with the de Glehn because we had no intention of doing that — but we built a simple engine to see the best results we could get with a given arrangement of valve gear. This engine had six wheels coupled, 6 ft. 8 in. in diameter with cylinders 18 inches in diameter and 30 inch stroke, and taking the two engines together, running precisely the same train, with the boiler pressed to 225 pounds per square inch, it was able to do the same work the de Glehn compound did and in fact took heavier loads, and as far as the coal consumption is concerned there is little to choose between them, because running with a high speed, with such a full stroke as 30 inches and being fitted with piston valves, we are able to get an early cut off and late exhaust which we think practically compensates for the compounding in the de Glehn engine. I have had the pleasure of a talk with Mr. Vauclain, who, as you all know, invented a compound engine, and he naturally thinks the arrangements on the de Glehn compound are not altogether necessary, but we think, and I believe those who know anything of the engine agree with me, that the great advantage of the de Glehn is that you can work your high pressure cylinder at 25 per cent cut off, and if necessary, you can work your low pressure cylinder in full gear, so that you are able to get the full advantage of compounding. I believe from what I have seen — and I have ridden on the engine myself — that I can say that the great advantage of the de Glehn compound over any other system I am acquainted with, is the advantage of having the two engines entirely independent.

I am sorry Mr. Whale is not here to give us his experience on the North-Western, but Mr. Webb, who preceded him, had his compound coupled together so that the high pressure or low pressure, as the case may be, was worked with the same valve gear, so that if the high pressure was arranged to cut off at 25 per cent, the low pressure was arranged to cut off at the same point. Mr. Whale found by disconnecting the valve gear and having separate engines he got better results. I think that we cannot have a better example of the efficiency of the compound than is given in this ability to operate the engines entirely separately. Another great advantage of the de Glehn is that you have a balanced compound; you have your high pressure and low pressure, as the case may be, coupled to the crank shaft and the other engine coupled to the middle pair of wheels, which does away with the heavy balance

weight and there is no doubt it is the finest running engine I have ever been on.

We have been so pleased with the result of this engine, and knowing what the practice is in America in regard to these powerful locomotives and high centered boilers, that we have ordered two more engines of the de Glehn compound type — the largest made — and expect these two engines to be delivered some time next month so as to have them ready for the summer service which will commence again on the 1<sup>st</sup> of July. I think the run from London to Plymouth without stop is the longest run in the world. I had the pleasure of riding on our engine n° 98 that left Paddington, with a train of seven eight wheelers, averaging in length 60 feet over head stocks. I timed the train and we passed the 60 mile post in 59 minutes; we passed Swindon 77  $\frac{1}{4}$  miles from London, in 76 minutes. The first time we slowed was going through Bath, where there is a sharp curve. Bath is 106 miles from London and we passed that in 104 minutes. We then continued to run on schedule time down to Exeter where we had to slow again. The engine was pressed to 200 pounds per square inch and if you glued the needle of the pressure valve to the gauge itself it could not have kept on the 200 mark better. After leaving Newton Abbot we had a bank to climb, a grade of 1 in 43 for 2 miles, and another grade of 1 in 51 for about 4 miles — before Plymouth was reached. We stopped outside and got into Plymouth two minutes late.

I was going through to Penzance, and we changed engines at Plymouth. After stopping at Truro, we reached Penzance, seven hours from London, one minute before time. This goes on through the summer months day after day in both directions, and the de Glehn compound is doing the work no better than engines of our own make, and from the experience I have had, we found no actual saving in the coal consumption, and I do not think, except on a perfectly level road, that you will get all the advantages of the compound, because when you have grades such as we have below Exeter, there is no doubt a simple engine would give a better result than the compound, as you cannot have a compound engine without increasing your mechanism which is always a great disadvantage to a locomotive.

I agree with the writer of the paper in his statement of yesterday, that the great point to be studied in the design of locomotives, is to make them as simple as you possibly can and knowing the trouble we have had with our modern powerful locomotives, it is encouraging, indeed, to hear the remarks I have from the American engineers when they express themselves as not being satisfied altogether with their new modern engines, because of their increased cost of up keep. I have no doubt they have not had time to thoroughly work out the details necessary to construct an engine of such powerful dimensions. If you are going to have a powerful locomotive and have it thoroughly efficient, it must be worked out in proportion — that is to say, if you increase your power, you do not want to decrease the life of your locomotive. If you do, you make your running expenses and expenses for maintenance very high indeed. I should like to hear from both the Continental and the American engineers what is the great trouble they are experiencing at the present time

from their big locomotives carrying high pressures. I know what they are in our country and I should be glad if the other engineers would tell us the greatest trouble they have with powerful locomotives.

**The President.** — Mr. W. Forsyth has made some remarks to me which I think you will be interested to hear fully.

He believes, as Mr. Muhlfeld has pointed out in extreme detail in his paper, that the principal difficulty has been the leaky tubes and cracked plates and leaky fire-boxes. Now, he has the idea that these failures are associated with high pressures and he would be glad to know the opinion of the French engineers on that idea, because they were the first to use high pressures on locomotive boilers, and the American engineers have really been encouraged to do the same, because they regarded that practice as successful in France. Of course, in the United States they use steel fire-boxes and steel stay bolts, and with a strong material the fire-box does not fail for lack of strength as the stays in the copper fire-boxes do — it is a matter of strength rather than of anything else. But in this country, says Mr. Forsyth, where they have strong stay bolts, they still have failures and these they believe are largely due to expansion and contraction due to irregular temperature in the boiler on account of the want of proper circulation of water. It is rather difficult to go into that in detail, but Mr. Forsyth believes the latest ideas on this subject are based on that fact. He has wondered since he has been here whether the French engineers have as much trouble with high pressure boilers as they do in this country, and if so what their idea is as to the cause of it and whether the construction of the boiler itself has anything to do with it. In Mr. Muhlfeld's paper, he shows two types of boilers, one of which he regards as a good design and the other a poor one, so far as the matter of circulation is concerned. One of the principal troubles they had here is on account of leaky tubes, and that appears difficult to understand and difficult to remedy, but as he said they believe that with more careful attention to temperature of water in the boiler, much of the trouble can be prevented, and in fact they know that it has been prevented by attention being given to the manner of feeding the boiler. If there is something in the quality of French locomotives which enables them to avoid these difficulties he would like to know what it is. It may be possibly that the boilers are better constructed in the first place. Mr. Forsyth has an idea that American boilers are built too rapidly, they are turned out of some shops too fast, at the rate of five or six locomotives a day and at that rate the best work cannot be done. If you start with a boiler which is not put together properly you cannot maintain it and keep it tight. Perhaps the French builders are more deliberate and the English, too, are more careful in the manner in which they construct their boilers in the first place. That is the question set forth by Mr. Forsyth.

**Mr. H. C. King,** Great Western Railway, Great Britain. — Until comparatively recently our boiler pressures were confined to 150 pounds. We have, however, in

the last two years had extensive experience with pressures of 165 and 180 pounds, and more recently with pressures from 200 pounds upward, 225 pounds being our maximum. Whether an Englishman is entitled to take credit for anything is a matter of doubt, but I may say that at our works in Swindon, the excellence of our manufacture has been such that we have not been troubled any more with a pressure of 225 pounds than we had previously with 150 pounds. In explanation of that perhaps I may be allowed to say that the difficulties presented to us are largely due to hard water, which in the case of the flues lead to the changing of the flues long before the endurance of the metal used has been reached. We have not, on the Great Western Railway, any other metal in use than iron or very mild steel, but in all such cases we have been put to the necessity of removing the tubes owing to the deposition of the scale long before the endurance or life of the tube has been reached. Arrangements have been made by Mr. G. J. Churchward, superintendent of our locomotive, carriage and wagon department, for the generous provision of water-softening plants both on English and American types at different points along our line where the trains take up their supplies, which we believe will obviate that trouble.

I beg leave to raise a question with regard to the remarks of the least speaker, who said that the American practice was to use steel plates with steel stays. In our insular ignorance, perhaps, we always regarded the American practice as having mild steel plates associated with iron, some times boiler iron stays, so that the use of short length steel stays struck me as being a matter of which I had not previously heard. We have in England pretty well settled down, after extensive acquaintance with alloys, many and peculiar, to copper stays on the fire line and iron stays elsewhere of short lengths; but in such Belpaire boilers as we have, the stays where they approach 2 feet in length, usually the vertical stays from the ground of the fire-box to the outer shell, have been of a mild basic steel, which we took care to obtain from one source of supply only, our object being to locate what there might be of mischance or difficulty and saddle the right horse with the blame, but so far we have not had any occasion to blame either the horse or the saddle.

**The President.** — I want to thank Mr. King for correcting the statement that I made on behalf of Mr. Forsyth in regard to steel plates and steel stays. It was a slip of the tongue. I should have said steel plates and soft iron stays.

**Mr. T. Ronayne,** New Zealand Government Railways. — I might state, Mr. President and gentlemen, that the New Zealand railway system consists of 2,300 miles, and the gauge is 3 ft. 6 in. Naturally, in common with the rest of the world, and fortunately so far as New Zealand is concerned, which is a very progressive country, we found it necessary to increase the power of our locomotives. As a matter of fact the tractive power of our modern locomotives is from 50 to 100 per cent more than it was some years ago. The increase of power has been the source of considerable expense, inasmuch as the various sidings over the system had to be lengthened

so as to enable us to deal with long trains. The boiler pressures which were originally 140 pounds have been gradually extended to 160, 165, 175 and the standard boiler pressure is 200 pounds per square inch. We are building four locomotives on the de Glehn principle and I am very gratified to have been here to-day and to have the result of the experience of the gentlemen from France and elsewhere who have had experience with these locomotives; and I think I am justified in saying that the consensus of opinion is in favour of the four cylinder locomotive, and I feel encouraged to go on.

We have built the four engines, and it is probable that for our general work we shall make the four cylinder compound our standard. The increase of boiler pressures has not led to any serious difficulty in the matter of the maintenance of the boilers. We have good, bad and indifferent water, and with regard to the bad water we find that with careful washing out — we wash out with steam injector on the same lines as you do in America — it enables us to get our engines to work quickly again, as we have not any to spare, and it is much superior to cooling down the boilers more or less rapidly to enable them to be washed out with cold water. We find a great improvement has been effected in the condition of the tubes and the boilers generally by using that system of washing out of the boilers. We are troubled a great deal with lime, and in some of the districts we use the gum leaves of the colony — which grow in the country but not indigenous to New Zealand — eucalyptol leaves and we make a solution of that which removes the scale from the tube. We use it periodically with beneficial results.

We have considerable difficulties in New Zealand. We have what they call a 7 per cent grade, to express it in American terms, a grade of 1 in 14 to 1 in 15, which extends the length of some 3 miles. It is over a very rough country; the grade indicates that. It is very tortuous and five chain curves are very numerous. We work that grade on the Fell system, which I believe is the only remnant of that system at present in use.

We have had very great difficulty with regard to the axles on those locomotives, and with a view to getting them as perfect as possible, so as to handle the increased business with which we were dealing, we removed the axles and replaced them by nickel-steel axles, unfortunately with very poor results. Some of the axles only lasted six weeks. We spent a large sum of money in doing that, thinking we would make them good for ever, but we got in to deep water. The axles were made by a prominent firm in England, but since that experience with nickel axles, we have concluded not to go any further with them. We are more fortunate with nickel-steel piston rod material, which we get in very good shape. We also have in mind to try nickel-steel tubes. They have been ordered for about twelve months from the manufacturers in the United States, but the makers say they have not the right sort of metal from which to turn out the tubes, but we are living in hope of getting them. We are making an experiment with the spiral tubes, with a view of getting over the sparking difficulty. We have a very considerable expense sometimes in giving com-

pensation, although we are not legally liable for fires caused by sparks from our engines owing to the dryness of the country, although we use the double screen, still we are not absolutely free from sparking. I have been informed, chiefly through the medium of the *Railway Age*, which paper is very largely read in my country, that the spiral tube is the solution for the sparking difficulty. The tubes have been ordered, but we have not had any experience with them yet, but hope to have a better result from them than with the nickel tubes.

**Mr. Bowman Malcolm.** — I would ask, with regard to engines that are on continuous duty, is it the American practice to dump the fire at night, and let the engines cool down, or is it the practice to bank the fires? In my own practice, using South Wales coal — a very high quality of steam coal — we bank the fire, and never allow the pressure to go down below 60 or 70 lb., except when we are washing out the engine. We find much better results by maintaining the temperature, and thus avoiding leaky tubes and similar troubles.

**Mr. A. W. Gibbs.** — On the road with which I am connected, the general practice is to keep the fires banked.

While our President was speaking of the difficulties with the boilers, I recalled that I recently had occasion to look up the records of fire-boxes for several years past. The road with which I am connected has about 3,300 locomotives, 700 of which are heavy engines. Last year we had to put in 103 steel fire-boxes; the year before I think it was 75 and the year before that it was 102 if I remember correctly, so that you see the destruction of steel fire-boxes is not such a dreadful matter after all. With a depreciation of 5 per cent on an average of twenty years, that would mean that the engine would have during its life about two renewals of fire-boxes. There is a widely different practice and widely different results are secured with regard to fire-boxes, and it is my opinion that the trouble is more directly traceable to the question of water than any other one thing. The average of our engines is about nine years, so that you see we should be by this time feeling pretty well the effect of the large engines, of which there are about 700, so that I am not quite so despondent as Mr. Forsyth seems to be in regard to the great mortality of the large boiler due to the heavier pressure carried. At the same time, I am prepared to expect that with the locomotives having wide fire-boxes, we cannot expect so long a life as with the older type, largely because of the difficulty in keeping the grate covered with fuel.

**Mr. J. E. Muhlfeld, reporter.** — On the railroads I have been connected with, the general practice in the way of banking, cleaning and dumping the fire, as we call it, has been to depend entirely on local conditions. If we have through freight locomotives, supposed to be in continuous service, and they come in after reasonable length of runs, and the quality of fuel is fairly good, we try to clean the fire without knocking it all off the grates, saving the portion we can, freshening it with new fuel and then banking the fire. In the case of washing out boilers, the fire should be

knocked out, for either the hot or cold water washing system. I think that the condition of the fire and the grates and operating gear at the end of the trip, either in passenger, through freight or in local freight service, governs as to the dumping or cleaning of the fire. If there is sufficient good fuel left so that you can clean the fire, and the locomotive does not require to have the water released from the boiler, the intention is to always maintain the highest pressure permissible and the most uniform temperature; but where boilers require washing out, where there is flue work to be done, or when the fire is exceptionally dirty, it is better to clean off the grates entirely.

**Mr. Tordeux, French Eastern Railway.** (In French.) — Gentlemen, I entirely agree with the opinion expressed by my French colleagues on the subject of four cylinder compound locomotives. Seven years ago, my railway began using engines of this type for the first time and since then we have built nothing but four cylinder compound with four, six and eight wheels coupled; engines for expresses, for passenger trains, for goods trains and even tank engines with three coupled axles and two bogies which are to be delivered shortly and are to haul the passenger trains in the neighbourhood of Paris. We thus have two hundred and sixty-four cylinder compound locomotives now in service, and we shall soon have three hundred and twenty or three hundred and thirty of them.

In deciding to build nothing but compound locomotives, we have been influenced mainly by the saving of coal which follows the use of this type of engine, a saving which is of really great importance to us owing to the high cost of fuel. We have not a single coal pit on our line, and consequently in addition to the cost of coal at the pit's mouth, carriage costs us 7 francs a ton (3s. 8·3d. per English ton). Moreover, although we use from 75 to 85 per cent coal dust, the present price per ton, delivered, works out at about 18 francs (14s. 7·6d. per English ton).

The first hundred locomotives we built had flat slide valves, but after the exhibition of 1900, we decided to try piston valves. Twenty new engines with six wheels coupled fitted with these valves were therefore built at the same time as a similar number of identical engines, but with flat slide valves. These different locomotives were compared against each other for one year, and the results were completely in favour of the engines with piston valves. We found that the engines with piston valves ran much more smoothly, they ran better as was appreciable especially on the engines devoted to fast services; moreover, these engines ran more cheaply and saved from 4 to 5 per cent in coal, owing not only to their lower resistance, but also to the reduced throttling of the steam. As regards the maintenance of the piston valves which we feared our men would experience difficulty with at first, it did originally cause us some trouble, but this only lasted a short time and as a matter of fact it is not more delicate or more wearisome than the maintenance of the flat slide valves. In view of the result of these trials, all the engines built since the experiments were completed, have been fitted with piston valves.

There is another point upon which we have also made careful experiments and that I should like to call your attention to : I mean steam jacketting.

Some engines were fitted with an arrangement for reheating the cylinders and steam boxes with steam-jacketting. In these trials, the engines were divided into two groups carrying on the same service; one of these groups used reheating for one month and gave it up the following month, and inversely for the second group; moreover the drivers were shifted from time to time, so as to eliminate the human factor. The results of these trials, persisted in for a whole year, were absolutely nil; we did not find any difference whether steam-jacketting was used or not. The loss in the steam-jacket must then practically equalize the loss at the sides and it does not seem that reheating of the cylinders possesses any advantages in the locomotives.

In conclusion, I should like to say a word in reply to Mr. Gibbs regarding lubrication.

Until the last few years we were using nothing on our locomotives but the wick lubricator and we had noticed that when the drivers used this they sprayed the parts rather than oiled them. Now, though we use fairly cheap oils, as we need enormous quantities, a reduction in consumption means a saving that is by no means negligible. In order to arrive at this saving, we tried on some new and on some old engines the pointed lubricator that one of our engineers had seen in America. This lubricator was applied to nearly all the moving parts : small and large heads of rods, slides of pistons and boxes and in these applications we tried to make it as easy as possible for the drivers to regulate the flow, to open and close the lubricator by putting in cocks to stop the flow without interfering with regulation. We were thus able to reduce the cost of lubrication 20 to 30 per cent and even in some sheds where special supervision was possible the reduction in consumption exceeded 40 per cent.

So all our new engines are now fitted with pointed lubricators and we are even going to put these lubricators on some of our old engines in place of the wick lubricators.

**The President.** (In French.) — Perhaps some engineer present may be in a position to afford us valuable information on the use of piston valves either in Europe or in America?

**Mr. T. Bonayne** — We have practically abandoned the slide valves in favour of the piston valves, although all of our slide valves are balanced after the American fashion and give good results, but we consider that we should be up-to-date and get a better release for steam and larger steam ways, and the result is highly satisfactory to us. We have determined to adhere to the piston valves for all of our locomotives. We had some difficulty with the rings at the outset, the cast-iron of an L shape, and they did not give entire satisfaction. We remodeled the design and since then we have had absolutely no trouble. We found the valve gear was a source of some trouble,

especially with the slide valves before they were relieved, but that has entirely disappeared now, and the wear and tear on the pins and motion generally is infinitesimal. The men who operate the locomotives, instead of being almost jerked out of the cab, as they used to be, can now with one hand reverse the engine under 200 lb. pressure. The Walschaerts valve gear has been used almost exclusively and it seems to give the best possible satisfaction.

**Mr. D. F. Crawford.** — On the Pennsylvania lines West of Pittsburgh, we had only made incidental experiments until about three years ago when we had ten *Atlantic* type passenger locomotives provided with the piston valves and at the same time purchased twenty-two engines, which were exact duplicates, with the exception of the valves and cylinders. Since that time we have added more *Atlantic* type locomotives, and they have all had piston valves. In the three years' experience we are satisfied that the results we have obtained with the piston valve in the service in which the engines are used will justify us in continuing it as the standard valve for passenger engines. The locomotives have the Stephenson motion and the slide valve engines and piston valve engines are exactly the same, in so far as the motion is concerned. We find that the locomotives with the slide valve will require the lost motion to be taken up between what we call general repairs. Some of our piston valve engines have run the entire time between general repairs without accumulating sufficient lost motion to warrant withdrawing them from the service for such repairs. The locomotives I refer to carry 205 lb. of steam, and although we have balanced the slide valve to a degree that in starting the valve will blow, the men find it quite difficult to handle them, but do not have the same difficulty with the piston valve. We also find that the piston valve engine has been rather more economical on account of the fact that we do not have the valves and the valve seats to face. On the twenty-five piston valve engines which we have, there have been a few broken rings, not over a half dozen, but they do not give any other trouble, except some little leakage, and the engines get back to the terminal without giving up the train. For freight locomotives, while the piston valve is being considered, it has not been put on any engines in service.

**The President.** — Mr. Muhlfeld wishes to make some observations on the discussion which has taken place.

**Mr. J. E. Muhlfeld.** — Mr. Chairman and gentlemen : From the standpoint as the reporter for America, it has been very interesting, indeed, to note the different arguments which have been brought up in this discussion, especially by our colleagues from other countries. I have especially noted the growing sentiment towards a more uniform solving of the general problems that affect the locomotive service in all countries. It is very gratifying to note from the discussions we have had, that there is a tendency to standardize the various practices, and if this can be increased to the same extent in the next five or ten years as it has been in the last five years and as represented by the present practice, we can pretty nearly arrive at a

standard (with the exception of the detail problems which affect locomotives for local conditions) which will meet the general requirements for locomotive service in almost any country.

I have made a memorandum of the various features which have been brought up, and will commence with the high pressure of steam. From the arguments on this question, I notice that in the foreign practice, in connection with simple locomotives, you make use of pressures from 180 to 190 lb., or possibly up to 200 lb.; in compound practice, you make use of pressures up to 200 and 225 lb. In modern American locomotive practice, the simple locomotives average about 200 lb. pressure — in some cases of switching locomotives the pressure is 180 lb. — but in many cases simple, high speed locomotives, pressures are made use of from 210 to 225 lb. In connection with compound locomotives in this country, the pressure has been increased to as much as 235 lb. I think we can average all modern simple and compound locomotive construction in this country and it will be from 200 to 225 lb. pressure. These facts, I think, give an average for the various countries of about 200 lb. for all types of locomotives and that is getting pretty close to a high pressure proposition.

In compounding, the foreign practice shows that the duplex system, balanced four-cylinder and the two-cylinder compound types have been pretty well perfected, and in some countries practically adopted as a standard. In the United States and Canada, the compound locomotives which were first put in use, were deficient in many details of design as well as in construction, and I think that our experience with the compounding, which was inaugurated at the same time that the tractive power was greatly increased, did not result to the best advantage and has no doubt been responsible for the compound principle being retarded in connection with locomotives which are being built to-day. The four-cylinder balanced types are coming into use now, and we expect to get good results from them under certain fuel, weather and service conditions. We have in use on the Baltimore & Ohio the duplex system of compounding, and so far, although the locomotive has only made about 14,000 miles, we have gotten good results and do not anticipate any embarrassment. Of the two-cylinder cross-compound locomotives, there are a number in service in Canada and the United States. We have some on the Baltimore & Ohio, and while we are converting to simple some of the four-cylinder compound types, we do not propose to simple any of the cross-compounds, and even when they require new cylinders we expect to maintain them as cross-compounds. The division on which they run is fairly level with a few slight grades; the distances between fuel and water stations are long; the total runs average from 125 to 150 miles in length, and it is the longest haul we have for company's use fuel. The locomotives have a very good tractive power for starting trains and haul long and heavy trains, some trains having 125 cars. Altogether the cross-compound type of locomotive has given better results, so far as the compound principle is concerned, than simple cylinder types of locomotives operating under these conditions.

In the distribution of stresses over four instead of two points, that has been more thoroughly worked out in some of the foreign countries, but we believe that if the transportation department requires us to develop a greater amount of tractive power in one unit, we shall have to go to the distribution of the maximum stresses over four points instead of two. In developing from 40,000 to 50,000 lb. tractive power at the cylinders we have almost reached the limit of the amount of force to be transmitted to two crank pins and two main driving boxes, and in the operation of the motion gear and the cylinders, if we concentrate the development of power any further than we have, we shall only aggravate the troubles we have been through already; so it seems from what the practical results have demonstrated, and from what we have learned from other countries, that a greater distribution of these stresses is what will have to be followed out.

In superheating, quite a number of tests are being made, some with the Schmitt and other superheaters in Canada and with the Cole superheater in the United States. From personal observations as to the application of the superheating, I think it is to be regretted that we have not developed the superheating more in comparison than the compounding. I am satisfied that if our initial expenditures on capital account had been more largely made on superheating apparatus, than on compounding devices, we would have gotten better results and would not have had to make the betterments and expensive renewals and repairs which we were obliged to make on certain compounds. I think the development of superheating, either in connection with, or independent of, simple or compound locomotives, will be considerably greater in the future.

In motion gear, the increasing of the diameter of the main axles on account of increased tractive power, and the increasing of valve travel, has made it necessary to design very large eccentrics and straps, and on account of the larger diameter of the wheels, and at the same time trying to maintain a reduced length of rigid wheel-base to meet the curvature conditions and develop a locomotive which will give good tractive qualities, it has been necessary to complicate the motion gear of the Stephenson type to such an extent, as compared to the Walschaerts or similar type, that we now have about double the weight, many more parts for maintenance and lubrication, and an unsatisfactory gear which is most undesirable. Quite a number of Walschaerts' gears have been applied to locomotives built in the United States in the last couple of years and so far, from the investigations I have made, I think the results have been quite satisfactory. We look forward to considerable development in that type of gear in connection with American locomotives.

As to the diameter of driver wheels, I think the average size now being used in both foreign countries and the United States is about the same, 6 or 7 feet for passenger locomotives and about a 5-foot wheel for freight locomotives. Our locomotives in the last five years have been constructed with driver wheels averaging rather too small in diameter. The large amount of power developed and the increased number of revolutions per mile has been hard on the machinery and also on the

tracks; and, of course, the greater number of revolutions per mile, the more cylinders full of steam per mile and we feel that it has resulted in some waste of fuel. We much prefer the increased diameters of the driving wheels and increasing the length of the stroke, to maintain the cylinder diameter of the smallest possible dimension.

The piston valve will no doubt become more prominent each year, especially in connection with passenger locomotives. In freight locomotive design there are some features about a piston valve which are not so desirable as flat valves, especially where you have a great deal of drifting or considerable condensation. But with the improvements made in piston valves, there should not be any difficulty in overcoming these troubles. I think the application of the piston valve has been somewhat retarded on account of the first valves, of that type being put into service in connection with compound locomotives. They had a large number of packing rings, and the design and construction was such that we had a great deal of difficulty in maintaining them; but by a more simple design of piston valves such as can be made for simple locomotives, or four-cylinder balanced compounds, or cross-compound types, there should be no difficulty in working that problem out to good advantage.

With regard to the use of nickel-steel in forgings, it has not been used to any considerable extent, on account, in the first place, of the difficulty in securing metal of the proper specification, and due to, secondly, some trouble experienced in the use of nickel-steel which has been furnished. For that reason, the use of that material has been very limited in this country, and I think that can be said for all countries. Steel castings have been largely used to reduce weight and increase strength. I think that processes will be developed as the manufacturers of that class of material goes on which will produce castings suitable for all requirements.

There are some matters in which the foreign and American practice differ considerably, and one is in the lubrication. We have not been entirely successful in the lubrication of slide valves by the sight feed or gravity method. If the pressures are to increase, and we are to use superheating, we shall have to make use of a positive pump action control, or something which will insure us positive feed and which we cannot get with the present methods.

In the use of tail rods for pistons, we have not felt it was necessary in connection with piston heads or cylinders as large as 35 inches in diameter. Where we had difficulty in maintaining tail rods, on account of the buckling of piston rods and the wear and tear of the tail rod bushing used to keep up the alignment, we cut off the tail rods and have had no trouble since. Taking it as a general proposition, we found there was no more liability of failure nor any more wear at cylinders of locomotives of the cross-compound type, where we removed the tail rods from the 35-inch pistons, than where we had them in use.

In connection with frames, there has been a great deal of trouble with breakage, and from observations on several different roads, I have concluded it has been due largely to insufficient bracing between the boilers and the frames, and insufficient

bracing between the frames themselves. Neither has there been a good distribution of metal to give necessary strength where it was needed, and in other cases breakages have been due to defective material.

In the future development of American locomotives, we should look more thoroughly into the foreign practice, and learn whether the application of a good type of slab or double plate frame is practicable and whether it would not give better results.

Another good foreign practice is the use of tank locomotives. We have used them only for such service as six wheel coupled types are adopted for and for suburban use. It seems advisable that in America we should look into that subject more thoroughly and get the results of foreign practice and see if we cannot concentrate a greater amount of adhesive weight and do away with a certain proportion of non-adhesive weight for locomotives that do not have time to turn at the terminals, and which are used in the handling of local traffic, suburban service, local freight runs, and switching service. It seems to me that in such service, where we require maximum tractive effort to start trains and accelerate them rapidly, it is desirable to investigate the results from the tank locomotive.

In the use of locomotives with flexible wheelbase, the foreign practice has been developed more than here. The Baltimore & Ohio has put such a locomotive into service this spring. It has given satisfactory results. It has a total wheelbase of 30 ft. 6 in., a rigid wheelbase of 10 feet, with 334,500 lb. total weight. In comparing it with consolidation types of locomotives with the weight of 173,000 lb. on drivers and 16 ft. 6 1/2 in. rigid wheelbase, we find the flexible wheelbase locomotive will traverse curves on which the consolidation type of locomotive would become derailed.

From the conversations I have had with some of the foreign representatives, and what we have gained from this meeting, it would seem that with regard to the initial design and construction, and maintenance and care of locomotives, the foreign practice is to give more attention to these details. With our traffic conditions, the necessity of getting power to move the trains at any cost is so great, that the inspection, maintenance, classified repair work at the general shops, and care in operation, have all been neglected. Everything has been directed to the one feature of moving traffic, and now that the railroads are becoming more developed and the mileage extended, and they have all the mileage they can handle with the business originating, it seems to me the motive power people should take more interest in developing good initial design and better operation and maintenance in connection with the locomotives now on hand and those to be purchased.

In the matter of compounding, the American railroads have developed the compound locomotive more for the purpose of increasing hauling capacity, while in the foreign practice, as has been brought out in the discussion, while you consider the hauling capacity, you also work out refinements in design and do not overlook the efficiency and economy which should be brought about by that system. You have developed the four-cylinder compounds for high speed, and you have less wear and

tear on machinery, less wear and tear on track and the design has been such as to secure more benefit from the compound principle. I think the whole discussion resolves itself into the conclusion that the compound feature is the principle that must give results in high speed service when properly worked out.

In deciding on whether the simple or compound type of locomotive will be used, the cost of fuel is an item of considerable importance. The average cost of fuel in the United States will run from about 1 to 2 dollars per net ton on tender, whereas from the remarks made here, I am led to believe that the cost in some of the other countries will average from 2.50 to 4 dollars per ton net. The saving to be effected in compounding is mostly through the reduced boiler stresses and fuel consumption. In order to produce that saving, we must apply it to the coal actually consumed during the time the locomotive is hauling cars. Locomotives stand around terminals and burn fuel; they drift on the line and burn fuel and they do a good deal of switching along the line, in full stroke, which is wasteful; the pop valves relieve steam, and there are many other factors which enter into the fuel consumption and the saving that the compound will effect is only what can be applied to the coal that is burned while the locomotive is actually pulling cars. From observations we have made, we have figured that about 25 per cent of our fuel is burned when locomotives are not pulling cars, and the saving that the compound principle would effect on locomotives which would burn 12 tons of coal from one terminal to another, would have to be applied on only 9 tons of coal, because when you are not using steam, you are not effecting any saving due to the compound system.

The failures of boilers on account of the breakage of stay bolts and rupturing of side sheets has been referred to. The investigations we have made of failures where mild steel has been used for fire-box plates and good wrought iron for rigid stay bolts, has developed in many cases the fact that the same spacing has been used as in older practice. Where the pitch of the rigid stay bolts has been from 3  $\frac{1}{2}$  to 3  $\frac{3}{4}$  inches as compared with 4 inches as formerly used with the same diameter of stay bolt applied, we have overcome the deficiencies brought out on account of the previous practice, and with the present boiler construction where proper attention is given to increasing the width of water legs, to provide ample flexibility, we do not feel that we shall have the same disturbances and bad results that we have had from the past practices.

**The President.** (In French.) — In his report, Mr. Muhlfeld has touched upon a very interesting point, namely the use of locomotives with great flexibility and immense adhesive weight. There is, for instance, the Mallet locomotive that has been tried on the Baltimore & Ohio. Perhaps some information could be given to the section on experiments that have been carried out in different countries in this direction.

**Mr. Asselin.** (In French.) — In the very interesting remarks which he has just made, Mr. Muhlfeld stated that so far there are in existence very few powerful tank engines,

at least for goods trains. He suggested that it might be a good thing to go further in this direction.

I therefore think it may be of interest to mention the building by the Northern of France of an engine of high power designed by Mr. du Bousquet, chief mechanical engineer, which can be compared with the Baltimore & Ohio Railway's Mallet engine and which exactly corresponds with the conditions laid down by Mr. Muhlfeld in that it is a tank engine with flexible wheel-base.

It is a four-cylinder compound goods locomotive, with a steam pressure of 16 kilograms (228 lb. per square inch); its boiler is exceptionally powerful for a European engine, for its capacity is 8 cubic metres (283 cubic feet), the grate area is 3 square metres (32.29 square feet), the heating surface 244 square metres (2,626.49 square feet) of which 12 square metres (129.17 square feet) belong to the fire-box. The tubes, of which there are 130, are 4.75 metres (15 ft. 7 in.) long and 70 millimetres ( $2\frac{3}{4}$  inches) in external diameter. They are Serve tubes.

The intention was to build a locomotive capable of hauling 1,000 tons (984 English tons) up a gradient of 10 per mil at a speed of 25 kilometres (15.5 miles) an hour, and the same load at between 45 and 50 kilometres (between 28 and 31 miles) an hour on lines without gradients exceeding 5 per mil. With this object the diameter of the driving wheels was 1.455 metre (4 ft. 9  $\frac{5}{16}$  in.).

The boiler of the locomotive is carried on two independent bogies and this is what differentiates it from a Mallet engine.

For the two ordinary bolsters is substituted a simple central beam which carries the boiler. Behind, this beam is provided with two cross-pieces and these, through pivots, are carried on four supports attached to the bogies. The boiler therefore rests behind on these four supports and on the pivot of the bogie. In front it rests solely through the pivot of the bogie which is spherical. Like the Baltimore & Ohio engine mentioned by Muhlfeld in his interesting report, the two motor bogies are six wheel coupled. In order to avoid difficulties with the cylinders and to limit the adhesive weight to 15 tons (14.8 English tons) per driving or coupled axle, an extra carrying axle has been added per bogie behind each cylinder.

In order to steam properly, the high pressure cylinders are carried on the trailing bogie and the low pressure ones on the leading bogie. The steam is carried to the H. P. cylinders through the pivot of the trailing bogie. From the H. P. cylinders the steam is conveyed to the L. P. cylinders through ringed metallic pipes.

The total length of the engine is 16.18 metres (53 ft. 1 in.) and it weighs 78 tons (76.8 English tons) empty. In working order it weighs 105 tons (103.3 English tons). Its tractive power is 12.800 tons (28,220 lb.).

**Mr. Flobert**, Northern of Spain Railway. (In French.) — Like almost all other companies, we have been induced to study the problem of engines of high power and the following is the solution at which we have arrived : the engine designed by my company is intended for hauling coal trains at a speed of 20 kilometres

(12·4 miles) an hour on a line with a continuous grade of 2 per cent and numerous curves, the radius of which is usually 300 metres (984 feet), but sometimes as low as 250 metres (820 feet). This engine is composed of two locomotives with three coupled axles and pony truck ahead, coupled to a single rear tender. The adhesive weight is 84 tons (82·7 English tons); the total weight of the whole engine is 120 tons (118 English tons); the total length is 25 metres (82 feet), which corresponds to a load of 14 tons (13·8 English tons) on each driving axle and 4,800 kilograms per metre run (3,220 pounds per foot) of total engine length, which figure cannot be exceeded owing to the limitations imposed by the dimensions, etc., of the track. The tractive power is 12,000 kilograms (26,450 pounds). It takes one driver and two firemen to handle the engine.

I am not giving these data as an example to be followed, but simply as a piece of information.

We have not adopted the compound system for the following reasons. First we run through a mining district where coal is as cheap as it can be, and secondly our staff is ill-educated and we are afraid that inconveniences might arise on this account.

Moreover, one of the great advantages of two-cylinder compounds is that at any given moment you can put a great strain on them. On the section upon which these engines are to be used, there is a continuous gradient of 20 per mil and consequently sudden strains are not necessary.

As I am speaking, I may as well reply to a question that was put about methods of preventing fires caused by sparks. We have had to pay considerable claims on this account. For the last year we have been trying an arrangement with double lattice work screens; it has succeeded admirably and we have decided to equip all our engines with them.

**The President.** (In French.) — With a view to terminating this very interesting discussion, your secretaries have drawn up some very concise conclusions which will now be read.

It will probably be advisable to add a few lines with reference to what has been said this afternoon, especially as regards piston valves.

If you approve the conclusions as suggested we shall submit them, with a few necessary formal alterations, to the general meeting which will finally consider them.

**Mr. Paul Dubois, secretary.** — The following are the conclusions :

“ The power of locomotives is more limited in Europe than in America, owing to the lower allowance of weight per axle.

“ European engineers generally agree in thinking that compounding admits of the construction of engines giving the maximum power and economy.

“ This system utilizes the steam very well and does not appear to increase to any

noticeable extent the cost of maintenance of locomotives; it does make the maintenance of the boilers more difficult, but that is due to their increased size and higher working pressure, which are necessary in all cases. Almost all locomotives built in France in recent years have four balanced cylinders. These engines, as well as compound engines of other systems, are also employed in other European countries, especially Germany, Austria, Spain, etc. Several engineers in Great Britain and Ireland express equal satisfaction from their use and insist on the advantage of separating the high and low pressure machinery. A number of American engineers also express opinions favorable to compound locomotives, which have given satisfactory results on the Atchison Topeka & Santa Fe Railway; the sentiment on this matter is, however, less unanimous in the United States than in Europe. The Congress has been informed of experiments made in New Zealand with four-cylinder compound locomotives.

“ The introduction of American locomotives in Europe and European locomotives in America, has had the advantage of making known on both sides some interesting details of construction, particularly the light weight of the parts of European locomotives, and the syphon and sight feed lubricators of American locomotives.

“ Applications of superheated steam seem to increase in number, especially in America and in Germany, and seem to give good results.

“ The constantly increasing use of cast steel is observed, which in the United States has even been tried for cylinders.

“ The use of the Walschaerts' motion gear is extending in the United States.

“ A number of tests of automatic stokers have been made in the United States but as yet the results have not been definite. It has also been found that without the aid of these devices, but with proper arrangements of grates, the heaviest firing necessary at the present time can be effected without difficulty.

“ Finally, the Section has examined the use of articulated locomotives of great power on lines of irregular grades, particularly Mallet locomotives and those designed by the French Northern and Northern of Spain Railways. ”

**The President.** (In French.) — Mr. Muhlfeld asks me once again to call attention to the necessity of taking more pains about the details of the construction and the maintenance of American locomotives.

It seems to me that this would be laying too much stress upon a point which may have arisen occasionally but which is not general. It can be easily understood that a few orders may have been carried out too hurriedly in the United States; this occurs even in Europe where orders are however less numerous. Unquestionably our engines are not perfect and can always be improved. That is true of everything and to mention it in one of our conclusions would, it seems to me, be evidence of superfluous modesty. We do not claim to produce finality, but, on the other hand, need we state that American engines require revision in detail? If we are to accept a conclusion of this kind it must be drawn up in a very mild form.

I wish members would express their general views as to whether the proposed conclusions reflect the opinions of the meeting clearly. I should like to know now whether any delegates desire to offer remarks on the resolutions which have just been read before they are finally edited for the general meeting. Does any one wish to suggest any alteration, verbally or otherwise, before the resolutions are submitted next week to the general meeting.

**Mr. F. G. Wright.** — Mr. Chairman, I might mention that mechanical stokers have been tried on the Great Western Railway of England as well as in America.

**The President.** — Yes, and without success?

**Mr. F. G. Wright.** — I wouldn't put it "without success" — "they have been tried".

**The President.** — If no one has any further observations to make, the resolutions will then be edited, and go in practically as they are.

**Mr. F. G. Wright.** — Would it be impossible for the members to see them before they are finally passed? You see, it is rather difficult to follow them very closely

**The President.** — You will be able to see them at the beginning of the next meeting, that is, on Monday morning, if you will come a little before the time.

**Mr. J. E. Muhlfeld, reporter.** — From conversations I have had, and arguments made on the question, I think the general opinion is that a little more care should be taken in America in the design, construction, maintenance and operation of the modern locomotives than has been taken in the past. It appears that the details in all countries have not been worked out to the very best advantage in all cases, and I think the matter in every respect ought to be gone into a little more thoroughly. I know we are of that opinion here, and I think from what some of the members here have stated to-day, and the experiences they have gone through with, that it can be pretty well followed out not only in America but in other countries.

**The President.** — Although Mr. Muhlfeld appears very modest about what has been done over here, he certainly shows in his paper that a great deal of very splendid work has been done, and although there may be some truth in his statement that more care should be taken in detail, still that should not lead us to suppose that he himself and his American colleagues have not obtained very remarkable results.

**Mr. Bowdian Malcolm.** — Would not that kind of a resolution, Mr. Chairman, be tantamount to saying that the locomotive engineers have not been doing their duty in the past? and so far as I am concerned personally, I am not prepared to agree to that. I do not know what is the feeling of my friends, but speaking as a Britisher, I think we work out our details very well. If we do not, certainly it is not from want of pressure of business, or want of time or of strict attention to every matter of

detail. I can quite understand that had the same tremendous pressure been brought upon us, that has evidently been brought upon the American railway companies, due to the rapid growth of traffic, we might possibly have had to adopt the same measures temporarily.

**The President.** (In French.) — That would really mean laying greater stress on Mr. Muhlfeld's observation than he means to convey. He has just told me so himself.

— As no one else desired to speak, the conclusions were put to the meeting and adopted.

The next meeting will take place on Monday next, in this hall, at 9.30 in conjunction with the 3<sup>rd</sup> section.

**Mr. F. G. Wright.** — I should like to ask one question before we go. Can any American locomotive engineer tell me what is the limit of weight allowed on any one pair of wheels and what is the limit of the total weight of the locomotive?

**Mr. J. E. Muhlfeld.** — The limit on one pair of wheels at the present time is about 62,000 pounds for a pair of driver wheels. That is about the highest.

**Mr. F. G. Wright.** — What is the total weight?

**Mr. J. E. Muhlfeld.** — Total weight on the driver wheels?

**Mr. F. G. Wright.** — Total weight of the engine itself.

**Mr. J. E. Muhlfeld.** — Oh, the total weight of the engine itself? Over what wheelbase?

**Mr. F. G. Wright.** — Over the longest wheelbase you have.

**Mr. J. E. Muhlfeld.** — Distributed over 30 ft. 6 in. wheelbase, 334,500 pounds.

— The meeting adjourned at 12.30.

# DISCUSSION AT THE GENERAL MEETING

---

Meeting held on May 11, 1905 (afternoon).

---

MR. STUYVESANT FISH, PRESIDENT, IN THE CHAIR.

GENERAL SECRETARY : MR. L. WEISSENBRUCH.

ASSOCIATE GENERAL SECRETARY : MR. W. F. ALLEN.

The President read the

## Report of the 2<sup>nd</sup> section.

(See the *Daily Journal of the session*, No. 3, p. 41, No. 4, p. 69, No. 5, p. 85, and No. 7, p. 129.)

“ Mr. J. E. MUHLFELD read an abstract of his report.

“ The conclusions of this report are as follows :

“ 1° Locomotives of great power, within the present clearance and weight limits, may be designed and constructed to remain modern for several years and produce a higher average speed and tractive power with less cost for locomotive expenses per unit of power developed, than that given by locomotives of large capacity in use to-day or from the previous lighter equipment.

“ 2° The efficiency and economy predicted and anticipated from the use of locomotives of great power have not been attained. Their development has been too rapid on the basis of the theoretical calculations which did not include the necessary factors for practical results, and also owing to the disregard of simplicity in design, substantial maintenance and speed as elements of economy.

“ 3° Locomotives of comparatively recent construction have been built without proper consideration for the use of railroad standard designs, specifications, practices and processes which continued experience may have determined to be more suitable and interchangeable than the standards of locomotive builders.

“ 4° The present ineffective load should be reduced by the use of design and material which will combine the least weight and greatest desired strength.

“ 5° The elimination of those individual preferences, patented devices, fads and frills which have no real value, by the use of simple, practical design and construction, will produce more satisfactory general results.

“ 6° The mechanical department supervision has often been curtailed when expansion of organization and direct, mechanical control should have been given to insure the desired performance. Changes in organization and methods have frequently been effected in preference to conservative management, with instruction, education and substantial recognition for the deserving rank and file.

“ 7° The locomotive maintenance and dispatch facilities have not always been developed to meet the proportionate increase in the locomotive dimensions, capacity and requirements, while slow line movement has made it necessary to increase average mileage by reducing terminal mechanical delay, during a period when more opportunity for maintenance and handling has been essential

“ 8° The tonnage hauled per train, has frequently precluded the making of an average speed between initial and destination terminals that would be productive of efficiency and economy in locomotive operation.

“ 9° Decreased efficiency has resulted from the irregular transferring and crewing of locomotives for long runs. The regular assignment of crews to locomotives and of suitable locomotives to shorter runs on regular districts, should accomplish the best results.

“ 10° Provision for the cleanliness and care of employees and equipment on the line and at terminals, should receive more consideration.

“ 11° Personal supervision and investigation should govern in the construction and operation of locomotives of great power, whilst statistical information and correspondence should be limited and used with caution. ”

“ THE PRESIDENT invited discussion of the various conclusions in this report.

“ Mr. J. F. DEEMS (*New York Central & Hudson River Railroad*) stated that he fully agreed with Mr. J. E. Muhlfeld that it is not desirable to consider solely the economical operation of locomotives, but the entire railway as a whole, constituting a means of transportation affording the most advantageous service.

“ He then examined different special points, especially the use of devices for increasing friction at starting, which in his opinion have not as yet given all the results that might be expected. He then spoke of mechanical stokers, which it would be also interesting to see tested further. A discussion ensued on the use of these devices, in which a prominent part was taken by Messrs. J. E. MUHLFELD, D. F. CRAWFORD (*Pennsylvania Lines West of Pittsburgh*), F. G. WRIGHT (*Great Western Railway, England*), Alfred W. GIBBS (*Pennsylvania Railroad*), TH. LAURENT (*Orleans Railway*). The conclusion arrived at was that up to the present time, these mechanical stokers do not appear to have secured any considerable saving of fuel and are still in the experimental stage; furthermore, they seem to have given only

mediocre results in England on the Great Western Railway, and Mr. J. E. Muhlfeld expressed his belief that the hardest service required of locomotives of the existing types can be secured without the use of these devices. It would be very interesting, however, to continue experiments along this line.

“ Mr. J. F. DEEMS made some remarks on the most desirable forms of fire-boxes. He has ascertained that narrow fire-boxes wear out less quickly than wide ones, although the latter in certain cases appear to be essential in order to secure the necessary amount of grate surface. He cited also a number of cases of breakage of cylinders which might unquestionably have been avoided by the use of pressed steel.

“ Mr. R. P. C. SANDERSON (*Seaboard Air Line Railway*) recommended at all events the use of hard cast cylinders with soft cast jackets.

“ Ideas were exchanged in regard to the use of the compound system, which appears to have been confined in America until recently almost exclusively to two-cylinder engines or four-cylinder engines without crank axles.

“ The reporter was of the opinion that increased engine capacity could be best attained by compounding, but his opinion did not appear to be shared by the majority of the American representatives who took part in the discussion. Some stated they were not yet prepared to express an opinion on this subject. The saving secured by compound engines appeared also less noticeable on lines of irregular grades than on lines of light grades, and the decreased consumption of fuel is largely made up by the increased cost of maintenance.

“ While admitting the merit of the compound system with four balanced cylinders, Mr. J. F. DEEMS expressed fears on the subject of durability of crank axles, even when made from special grades of steel, owing to the very great increase in the power of the engines.

“ Mr. H. H. VAUGHAN (*Canadian Pacific Railway*) stated he had had an extensive experience with two-cylinder compound locomotives, and had noted in certain cases a saving of fuel, but also an increased cost of maintenance. He thought the use of superheating would give better results and he estimated at 10 per cent the saving of fuel thereby secured in connection with two-cylinder compound engines. Data supplied from various roads, showed that there will soon be in operation in America hundred and ten locomotives fitted with superheaters.

“ Referring to remarks made by the reporter regarding the insufficient investigation of certain details of high power engines, Mr. J. F. DEEMS called attention to the fact that these investigations were often rendered impossible by the haste with which orders had to be placed owing to the requirements of traffic.

“ After some remarks by Mr. A. BUCHANAN (*Central Vermont Railway*) and Mr. F. H. CLARK (*Chicago, Burlington & Quincy Railway*), Mr. A. LOVELL (*Atchison, Topeka & Santa Fe Railway*) reported experiments carried out successfully on his

system for the comparison of compound and ordinary engines under identical conditions doing the same kind of work. These experiments have proved that the compound engines were more economical as to the expense in fuel, but that their maintenance was slightly higher. Noting especially the comparative experiments made between simple and compound engines with four balanced cylinders, both using liquid fuel, these have demonstrated that for long and heavy hauls simple expansion engines cannot carry the same load as the compound engines and that the latter have shown a saving in fuel of 20 to 25 per cent with respect to the former. In this special case, it has been observed that the boilers of the simple expansion engines require more frequent repairs than those of the compound engines. This was due to the fact that the fire had to be forced to produce sufficient steam.

“ Mr. A. LOVELL thought positively that there is little difference between the cost of maintenance of compound engines and simple expansion engines, and if an increase in these expenses is observed, it is chiefly due to the increase in the power of the engines. He further added that the fears expressed by Mr. J. F. Deems as to crank axles do not appear to him to be justified.

“ Mr. E. SAUVAGE read the conclusions of his report.

“ These conclusions are the following :

“ a) *Wheel loads.* — An important point in considering locomotives of great power is the wheel load permissible. Most of the lines of any importance allow at least 7·5 English tons; frequently the limit is 8·5 to 9 tons. It is 10 English tons on several English railways; in the United States there are instance where higher wheel loads are admitted. If we limit ourselves to the continent, wheel loads hardly exceed 9 tons (8·86 English tons). But it is probable that the traffic of trunk lines will require a new increase in the power of locomotives for fast trains, so that it will be desirable to have tracks which can stand wheel loads of 10 tons (9·84 English tons). However, in order not to fatigue the rails too much, it might be specified that this limit of 10 tons (9·84 English tons) is only allowed in the case of locomotives constructed so as to keep within sufficiently narrow limits, at the highest speeds, the variations of load which are produced at each revolution of the wheels.

“ b) *Gauge of the tracks.* — The power of locomotives built for tracks of wider gauge than the standard, which are used in some countries (Spain, Portugal, Ireland, Empire of India, Russia) does not exceed that of locomotives running on standard gauge tracks. In order to benefit by the wider gauge, it would be necessary for the track to stand heavier wheel loads.

“ c) *Diameter of driving wheels.* — The diameter of the wheels hardly exceeds 2 metres (6 ft. 6  $\frac{3}{4}$  in.) with the fastest locomotives; at most it amounts to 2·10 or 2·15 metres (6 ft. 10  $\frac{11}{16}$  in. or 7 ft.  $\frac{5}{8}$  in.). Very high speed locomotives often have wheels of a less diameter than 2 metres (6 ft. 6  $\frac{3}{4}$  in.). This results in more than 300 revolutions per minute (this corresponds to a speed of 113 kilometres

[70·2 miles] per hour with 2 metre [6 ft. 6  $\frac{3}{4}$  in.] wheels). It would be desirable not to exceed this limit, in order not to have too much wire-drawing of steam ; but the disadvantages of large wheels are too great now-a-days. There would be an excessive increase in the weight of the locomotives and in the weight not carried on springs, and it would be necessary, as in the old locomotives, to reduce the diameter of the boilers. The disadvantages of great angular speeds is counteracted by giving large cross-sections to the steam passages, particularly by using piston valves.

“ On the other hand, with locomotives having six or eight coupled wheels, very small diameters are not used ; the diameter is hardly ever less than 1·4 metre (4 ft. 7  $\frac{1}{8}$  in.).

“ d) *Material used.* — The tendency is to use metals of good commercial quality ; the use of exceptional qualities, *e. g.* of nickel steel, is very exceptional and does not appear to be extending. The applications of steel castings are becoming more and more numerous and varied.

“ e) *Boilers.* — In the case of boilers, a grate area of 3 square metres (32·29 square feet), with a heating surface of 75 to 80 times the size, is obtained by the usual construction, with narrow fire-box. It appears to be difficult to obtain a much larger grate area on this plan, and this leads to the use of fire-boxes extending over the wheels. The large diameter wheels of the high speed locomotives must then be below the barrel of the boiler ; this can be done in the case of the *Atlantic* type. In Europe, several applications of these extended fire-boxes now begin to be seen, and it is probable they will multiply. For a long time, hesitation was shown in placing the grate above an axle ; particularly in England ; now, that position of the grate is generally accepted. No doubt the same will happen with regard to the extension of the fire-box above the wheels.

“ Very high pressures (14 to 16 kilograms per square centimetre [199 to 228 pounds per square inch]) are used at present, particularly with compounds. They necessarily involve an increased cost of maintenance of the boilers.

“ Serve ribbed tubes are generally used, particularly in France ; they are useful by making it possible to have a larger heating surface with a boiler of given size. The tubes must be cleaned out frequently and with care.

“ f) *Compound system.* — As a general rule, it is well established that the compound system results either in a certain economy of fuel for the same power, or more frequently in an increased power for the same fuel consumption. In some few cases, these advantages have not been realized ; this may depend on the particular use made of the locomotives or to some defects in the application of the system.

“ The use of four separate cylinders, acting by twos on cranks placed at 180 degrees to each other, makes it possible to obtain greater power without fatiguing the mechanism too much ; this arrangement balances the reciprocating masses, without producing vertical disturbances. As far as possible, the cylinders must act on two different axles, but these are coupled up.

“ It is advisable that each system should have a valve gear of its own, and that it

should be possible to operate independently the reversing shafts belonging to the two groups of cylinders, high pressure and low pressure.

“ g) *Valve gear*. — No mechanism has succeeded in replacing the valve gear consisting of a slide valve and link motion. The link motions most generally used are Stephenson's and Walschaerts'. Valve gear without eccentrics has the disadvantage of being disturbed by vertical displacement of the axles.

“ The only modification of these ancient systems, at all common, is the replacement of flat slide valves by piston valves, which reduce friction, and consequently wear, and make it possible to arrange larger passages for the steam. On the other hand, a piston valve may leak; it makes it absolutely necessary to have a valve for admitting air to the valve chest for running with regulator closed, and it is advisable to fit relief valves on the cylinder ends.

“ h) *Motion*. — Tail rods are to be recommended as soon as the diameter of the cylinders attains or exceeds 500 millimetres (1 ft. 7  $\frac{21}{32}$  in.). The lubrication of the slide valves and pistons is ensured in a continuous manner by lubricator pumps or by sight feed lubricators, placed under the eyes of the crew.

“ i) *Power of locomotives*. — With the present limits of weight admitted on the main European systems, locomotives can be built, thanks to the use of high pressures and the compound system, giving 1,500 to 2,000 indicated horse-power (1,480 to 1,973 indicated British horse-power).

“ j) *Locomotives for high speed trains*. — For heavily loaded high speed trains, locomotives of the Atlantic type or locomotives with six large coupled wheels are used. The choice between the two types depends on the nature of the service, on the profile of the lines, and also on the maximum wheel load allowed.

“ k) *Locomotives for general purposes*. — The locomotive with six coupled wheels and bogie, the wheels having a diameter of 1.5 to 1.8 metre (4 ft. 11 in. to 5 ft. 10  $\frac{7}{8}$  in.), is eminently suitable for a passenger train service, and the same locomotive can also haul goods trains satisfactorily.

“ l) *Locomotives for heavy goods trains*. — For heavy goods trains, there is a return to locomotives with eight coupled wheels, by preference with a leading pair of carrying wheels. These locomotives can exercise tractive efforts of more than 10,000 kilograms (22,000 pounds); they are limited by the strength of the couplings used in Europe.

“ m) *Tank locomotives*. — A very fair amount of attention is being paid to the design of tank locomotives with six or even eight coupled wheels, either for suburban train services, where very quick starting is necessary, or for very long distance runs. A leading pair of wheels or bogie is added either at one end, or at both, according to the nature of the service. Having two bogies, however, results in having very long and very heavy locomotives.

“ For the convenience of the service, these locomotives have long foot-plates for the crew, and carry large quantities of water and particularly of fuel, at least as much as is carried in the small separate tenders which are still in use.

“ n). *Locomotives with flexible wheelbase.* — The only type of powerful locomotive with its whole weight adhesive and arranged to run over specially sharp curves, which is largely used, is the Mallet type. However, most railways content themselves with locomotives of the ordinary types, without flexible wheelbase.

“ o) *General remarks.* — The railway industry does not escape a law to which nearly all industries are subject, owing to the rapid progress made in engineering, of almost continuously modifying its stock. As soon as new locomotives have been designed, which are very superior to those used previously, one is tempted to think that to some extent finality has been reached, or at least that during a sufficiently long period it will be possible to do without any new designs. It appears very tempting to keep for a long time to standard types, which are cheaper to build and easier to maintain; but progress, which does not stop, hardly allows definite types to be determined.

“ Thus on European railways, we find locomotives running developing 1,500 and even more indicated horse-power (1,480 and even more indicated British horse-power); but the continual increase in train weights and train speeds makes it necessary to-day to look for still more powerful locomotives, if not for actually existing needs, then at least for the needs of the immediate future.

“ But the old stock need not, therefore, be given up entirely, and the variety of existing railway services makes it possible to utilise locomotives well which are already of older date, but care must be taken that the unavoidable age of such locomotives, which is the result of the efflux of time, is not increased by an artificial age, by making them several years old already when building them.”

“ The conclusions of this report were then opened for discussion jointly with those of Mr. J. E. Muhlfeld's report.

“ Mr. MOFFRE (*French Midi Railway*) stated that if some American engineers find compound engines of small advantage because the increase in the cost of maintenance exceeds the economy in fuel, this opinion is not shared either by the French engineers nor by the engineers of the adjacent countries. It is true that a comparison is often difficult, as there are no engines exactly similar and doing exactly the same work. On the Midi Railway, he had occasion to compare ordinary engines with double cylinder compound engines which were rebuilt from the former and, therefore, had exactly the same boilers; this comparison has shown an economy of 20 per cent in fuel in favor of the compound engines. In France, the arrangements with four balanced cylinders is generally preferred, as it is thought to give a better distribution of work and a balancing of parts in the alternating movement.

“ Mr. Moffre also thought that if compounding should at some time be abandoned for superheating, the arrangement in four cylinders will still be the best. As to the question of crank axles, it does not exist in Europe, where axles of ordinary steel can be seen seven or eight years old, and having run more than 600,000 kilometres

(some 370,000 miles) without developing any cracks. Still better results may be expected with special steels.

“ The cost of maintenance of the machinery of four cylinder engines should in no case exceed by more than 40 per cent that of the ordinary engines; in some special cases, a saving has even been observed. As to the cost of maintenance of the boilers, that increase is solely due to the greater pressure, and it could without doubt be reduced by making certain changes in the present form of construction.

“ Mr. William McINTOSH (*Central Railroad of New Jersey*) stated, that he favored compound engines which, according to him, are an improvement, and he thought that if the first types have not realized all expectations, there is no reason for condemning the system, which can still be improved.

“ Mr. Karl STEINBISS (*German Government*) reported on experiments made in Germany during twenty years on compound engines of various types with two, three or four cylinders of the systems von Borries, Mallet, etc. At present, more than five thousand engines of these types are in service in Germany, both on passenger trains as well as on freight trains, and they give the best results with respect to economy. The saving in coal is on an average 10 per cent; excepting the starting valves, the repairs are not more costly than for the ordinary engines.

“ Recently another great question has been investigated, that of superheating. Thanks to the use of the Schmidt superheater and to the improvements made by Mr. Garbe, great progress is expected with simple engines with two cylinder engines with cylindrical or balanced valve chests. In concluding, Mr. Steinbiss remarked that German locomotives cannot attain such great dimensions as American engines, because the load per wheel is limited to 8 tons in general and to 9 tons in special cases.

“ Mr. Alfred W. GIBBS made some remarks in regard to the de Glehn type of locomotive built for his company by the *Société alsacienne*. This engine represents a very fine type of construction and is a very handsome example from the standpoint of lightness of parts; still the distribution of parts does not seem to him superior to that in American engines, and he stated that he had had a great deal of trouble with the copper staybolts and had had many cases of hot boxes. He would be very glad to have the opinion of French engineers on these points, and also regarding the best type of crank axles to adopt. He added that the de Glehn locomotive had excellent qualities in the matter of quick starting.

“ Mr. Th. LAURENT (*Orleans Railway*), replying to Mr. Gibbs, admitted that copper staybolts also give a great deal of trouble in France; that the upper rows have had to be replaced with manganese bronze staybolts, and they are still seeking a better metal. But these difficulties are also experienced with the American engines belonging to his company and appear inherent to the use of high pressure. As to hot boxes on drivers, he had tried American lubrication with wool waste and

derived no advantage from it, and after many cases of hot boxes with this system, he has returned to the system of wick lubricators, which, on the whole, seems to him preferable.

“ Returning to the question of firing, Mr. Th. Laurent reported that by using grates inclined at an angle of about  $18^{\circ}$ , a single fireman can fire 1,800 kilograms (about 2 tons) an hour on the powerful engines of his company. As to the charge of lack of elasticity, which some engineers allege against compound locomotives, he declared that this complaint is not justified. It has been shown, in fact, by very accurate tests made by his company that, within limits of load varying 50 per cent, the consumption of fuel per unit of work does not vary over 5 per cent.

“ Mr. ASSELIN (*French Northern Railway*) stated that on his line, copper stay-bolts have been replaced entirely with manganese bronze stay-bolts, the heads of which, it is true, burn out more quickly than those of copper stay-bolts, but by being careful to replace all stay-bolts whose heads have burned out, whenever the engine is laid off for any reason, all objections are overcome. For crank axles, his company has lately been using oil tempered gun steel, which gives entire satisfaction.

“ Mr. DUBOIS (*French Western Railway*) declared that his company had not observed any difference in wear between the three designs of crank axles which they have tried, and they have finally taken to using the least expensive design, *viz.*, parallel crank axles.

“ Mr. Bowman MALCOLM (*Midland Railway, Northern Counties Committee, Ireland*) estimated the saving of fuel by the use of compound engines at 10 per cent, and thought that they do not involve any perceptible increase in cost of maintenance. In his opinion, the difficulties experienced with them at the start should not interfere with their general adoption, and he spoke particularly highly of the four cylinder system.

“ After a remark regarding the maintenance of boilers and especially on the leakage at the joints with the tubes and the rupture of stay bolts a discussion arose in which Messrs. H. C. KING (*Great Western Railway, England*), Th. RONAYNE (*New Zealand Government Railways*), Bowman MALCOLM, Alfred W. GIBBS and J. E. MUHLFELD took part.

“ It appeared from the discussion that, in the United States, the use of soft steel fire-boxes with well spaced wrought iron stay-bolts proves satisfactory, the use of soft steel for stay-bolts being limited to Belpaire boilers. Some engineers prefer, if possible, to leave the fires banked during the housing of the engine, to avoid cooling and contraction. Mr. Alfred W. Gibbs stated that the wear of fire-boxes is not so rapid as it is commonly believed to be. Thus on his system, having 3,300 locomotives in service, 700 of which are heavy engines, in late years not more than 65 to 70 fire-boxes have to be replaced annually. In a boiler having a life of twenty years, the fire-box has been replaced on the average twice. Bad quality of

water and lack of care in construction, are the most frequent cause of boiler defects.

“ Mr. F. G. WRIGHT observed that experiments were made twenty years ago with compound locomotives on the Great Western Railway; these trials were given up because of damage due to the water entrained in the cylinders because of poor design. They have been taken up again, and last summer his company put into service a de Glehn compound locomotive which for the first time covered the distance from London to Plymouth (246 miles) without a stop. Mr. F. G. Wright believes that the superiority of this engine consists in its two independent mechanisms.

“ On the compound engines of the London & North Western Railway, where the two mechanisms were connected together, the result obtained were not so good and a very noticeable improvement was obtained after separating the distribution. The Great Western Railway has ordered two other engines of the same type, but of higher power.

“ Mr. Th. RONAYNE said that the need of increasing the power of engines has also made itself felt on the railroads of New Zealand. He has ordered four locomotives of the de Glehn type to be built, and the opinions expressed at the Congress by other members, indicate to him that he is on the right road. He reported that he has experimented with axles of nickel steel with little success. The use of the latter material has given better results with piston rods, and it is, at the present time, being tried for smoke tubes. He also intends to experiment with spiral tubes, in order to do away with the flying of sparks through the stack. The cylindrical valve boxes used in connection with the Walschaerts distribution give full satisfaction, and he prefers them to the balanced valve boxes.

“ Mr. TORDEUX (*French Eastern Railway*) stated that all locomotives built for the last seven years by his company have four cylinders. It has 260 of this type already in service and will soon have 320 or 330. The main reason for adopting the compound system on his roads is the economy in coal. There are no coal mines in the vicinity, and the cost of fuel is about 18 francs per metric ton (14s. 7d. per English ton). The first hundred compound locomotives which were built had flat valve boxes. After the Universal Exposition of 1900, the comparative experiments which were made with engines having cylindrical valve boxes and those with flat boxes, have shown that the former behaved better, that they were maintained easier and that they produced a saving in fuel of 4 to 5 per cent compared with the latter, which is due to the reduced throttling of the steam. All new locomotives are built at present with cylindrical valve boxes. The French Eastern Railway has also been making for a year past experiments with steam jackets, but without appreciable results. As to lubrication, the exchange of the wick lubricator for the American syphon lubricator has reduced the consumption of oil from 30 to 40 per cent. The use of the latter device is, therefore, being extended.

“ Mr. D. F. CRAWFORD confirmed what had been said on the advantages of cylindrical valve boxes. Trials made covering a period of three years by his company on an equal number of engines of the same type, one series having flat valve boxes and the other cylindrical, proved the superiority of the latter for passenger locomotives. This system reduces the throttling of the steam; it causes only an insignificant wear, while the flat valve box requires the adjustment of the distributing mechanism between two general repairs, and, finally, notwithstanding the extreme balancing of the flat box, the lifting mechanism is much more difficult to handle. Similar trials are being made on freight engines.

“ Mr. J. E. MUHLFELD then summed up the various points which were brought out by the discussion, and pointed out the main differences between American and European practice, as follows : The working pressure of the boilers is somewhat higher in the United States than in Europe; the slow adoption of the compound system in America, which is attributed to difficulties encountered at the beginning and to the different object aimed at by compounding, which in Europe is chiefly for the saving of fuel, while in the United States increase in tractive force is principally desired; the difference in the construction of fire-boxes and stay-bolts, etc. He considered that superheating was not sufficiently developed in his country and that it should attract the attention of engineers. He also called attention to the advantage which heavy tank engines for certain classes of service offer by utilizing the weight of the fuel and water to increase the friction on the rails, besides suburban traffic and shunting, for which this kind of engine is used exclusively in America. There are also very few locomotives with flexible wheel bases in the United States.

“ Mr. J. E. Muhlfeld's last remarks led Mr. ASSELIN (*French Northern Railway*) to refer to the construction on his line of an engine of great power, designed by Mr. du Bousquet, the chief engineer, which is simply a tender engine with flexible wheel base. It is a compound freight engine working at 16 kilograms (228 pounds per square inch) pressure, with an exceptionally powerful boiler for a European locomotive, as it has a capacity of 8 cubic metres (283 cubic feet), 3 square metres (32.29 square feet), of grate surface, and a heating surface of 244 square metres (2,626.49 square feet), of which 12 square metres (129.17 square feet) is fire-box. There are 130 tubes of the Serre type, 70 millimetres ( $2\frac{3}{4}$  inches) outside diameter and 4.75 metres (15 ft. 7 in.) long.

“ The object aimed at was to build an engine capable of hauling 1,000 tons (984 English tons) on a 1 per cent grade at a speed of 25 kilometres (15.5 miles) an hour, and this same load on lines having no gradients exceeding 0.5 per cent at a speed of at least 30 kilometres (31 miles) per hour. With this object, the drivers were given a diameter of 1.435 metre (4 ft. 9  $\frac{5}{16}$  in.).

“ Mr. Asselin gave some details of the construction of this locomotive, which is not a Mallet engine, as its boiler rests on two bogies with flexible wheel bases. For

this purpose, the two ordinary bolsters of the engine are replaced by a single centre beam which carries the boiler and rests on the two trucks.

“ Like the Mallet locomotive on the Baltimore & Ohio Railroad, of which Mr. J. E. Muhlfeld spoke in his report, the two driver trucks are each furnished with three coupled axles. As there is a fourth carrying axle placed on each truck, the weight per axle does not exceed 15 tons (14·8 English tons). The steam is led to the high pressure cylinders mounted on the rear truck through the centre bearing of the truck. Connection with the low pressure cylinders is made by means of articulated metal pipes. The total length of engine is 16·18 metres (53 ft. 1 in.). Weight, empty, 78 tons (76·8 English tons), and loaded, 105 tons (103·3 English tons).

“ Following the same line of thought, Mr. FLOBERT (*Northern of Spain Railway*) described an engine in course of construction for his company and intended for hauling coal trains at a speed of 20 kilometres (12·4 miles) an hour on a line with a continuous grade of 2 per cent and numerous curves, the radius of which is usually 300 metres (984 feet), but sometimes as low as 250 metres (820 feet). This engine is composed of two locomotives with three coupled axles and pony truck ahead, coupled to a single rear tender. The adhesive weight is 84 tons (82·7 English tons); the total weight of the whole engine is 120 tons (118 English tons); the total length is 25 metres (82 feet), which corresponds to a load of 14 tons (13·8 English tons) on each driving axle and 4,800 kilograms per metre (3,220 pounds per foot) of total engine length, which figure cannot be exceeded owing to the limitations imposed by the dimensions, etc., of the track. The tractive power is 12,000 kilograms (26,450 pounds). It takes one driver and two firemen to handle the engine.

“ THE PRESIDENT read the following draft of conclusions to be submitted to the general meeting.

“ This draft was accepted after Mr. J. E. MUHLFELD had drawn attention to the need for paying more care to details of construction and to maintenance of the engines. He pointed out that the maximum load per axle allowed in America was 62,000 lb. and the maximum weight for locomotives was 334,500 lb. for a wheel base of 30 ft. 6 in. ”

**The President.** — The following are the

#### CONCLUSIONS.

“ The power of locomotives is more limited in Europe than in America, owing to the lower allowance of weight per axle.

“ European engineers generally agree in thinking that compounding admits of the construction of engines giving the maximum power and economy.

“ This system utilizes the steam very well and does not appear to increase to any noticeable extent the cost of maintenance of locomotives; it does make the maintenance of the boilers more difficult, but that is due to their increased size and higher working pressure, which are necessary in all cases. Almost all locomotives built in France in recent years have four balanced cylinders. These engines, as well as compound engines of other systems, are also employed in other European countries, especially Germany, Austria, Spain, etc. Several engineers in Great Britain and Ireland express equal satisfaction from their use and insist on the advantage of separating the high and low pressure machinery. A number of American engineers also express opinions favorable to compound locomotives, which have given satisfactory results on the Atchison Topeka & Santa Fe Railway; the sentiment on this matter is, however, less unanimous in the United States than in Europe. The Congress has been informed of experiments made in New Zealand with four cylinder compound locomotives.

“ The introduction of American locomotives in Europe and European locomotives in America has had the advantage of making known on both sides some interesting details of construction, particularly the light weight of the parts of European locomotives and the syphon and sight feed lubricators of American locomotives.

“ Applications of superheated steam seem to increase in number, especially in America and in Germany, and seem to give good results.

“ The constantly increasing use of cast steel is observed, which in the United States has even been tried for cylinders.

“ The use of the Walschaerts motion gear is extending in the United States.

“ Generally speaking, all the engineers who have spoken of cylindrical valve chests appear well satisfied with them.

“ A number of tests of automatic stokers have been made in the United States and on the Great Western Railway of England, but as yet the results have not been definite. It has also been found, both in America and in England, that without the aid of these devices, but with proper arrangements of grates, the heaviest firing necessary at the present time can be effected without difficulty.

“ Finally, the Congress has examined the use of articulated locomotives of great power on lines of irregular grades, particularly Mallet locomotives and those designed by the French Northern and Northern of Spain railways. ”

— These conclusions were adopted by the general meeting.

## MISCELLANEOUS INFORMATION

---

[ 621 .132.8 ]

### 1. — Steam motor vehicle for the Indian State Railways.

By F. C. COLEMAN.

Figs. 1 to 5, pp. 1175 and 1176.

(*The Railway Age.*)

The figures 1 to 5 illustrate an interesting type of steam motor vehicle which was recently built by the Vulcan Foundry, Limited, of Newton-le-Willows, England, for operation over the Indian Northwestern (State) Railway. The coach is divided into three compartments, with seating accommodation for three first class, three second class and seventy-two third class passengers. The first and second class compartments are furnished with patent spring seats upholstered in buffalo skins, while the third class compartment is provided with plain wood seats. A luggage compartment occupies the space next the engine. The coach is fitted for lighting by Pintsch gas.

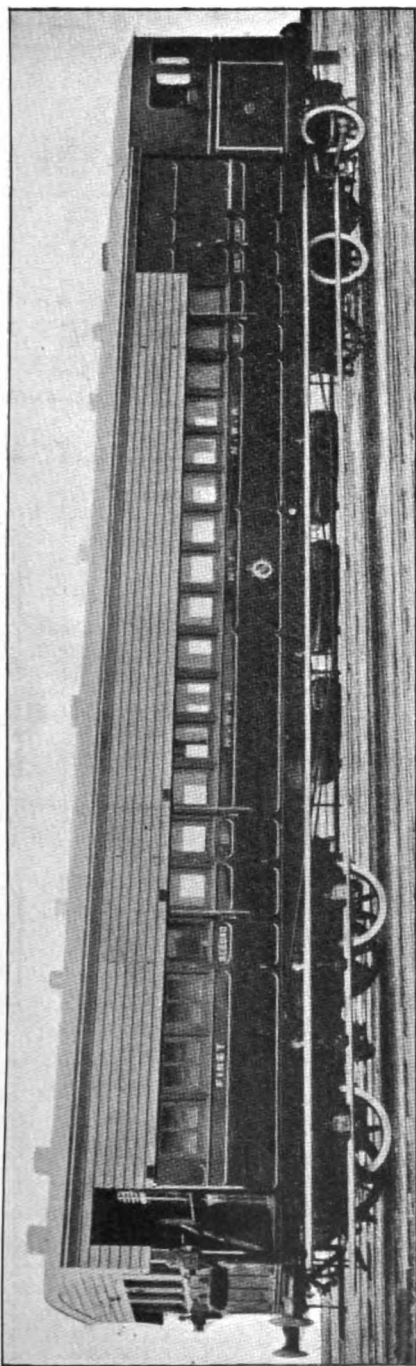
A small locomotive forms one end of the vehicle, having pivot castings and side spring plungers so as to allow of a slight rocking motion. A central spring on a stay behind the trailing wheels allows the weight to be adjusted. The boiler is reversed, thus giving the driver a good lookout and a roomy platform. The cylinders, 9 by 14 inches, are outside. The wheels, which are not coupled, have a diameter of 3 ft. 3 in. The total heating surface amounts to 300 square feet, to which the tubes contribute 252 square feet and the fire-box the remaining 48 square feet. The grate area is 9 square feet and the working pressure is 160 pounds per square inch.

The tanks have a capacity of 300 gallons and the bunker capacity is 18 cubic feet. The tanks are fitted with swiveling pipes so as to allow for filling from water cranes, without the drawing of hose into the cab.

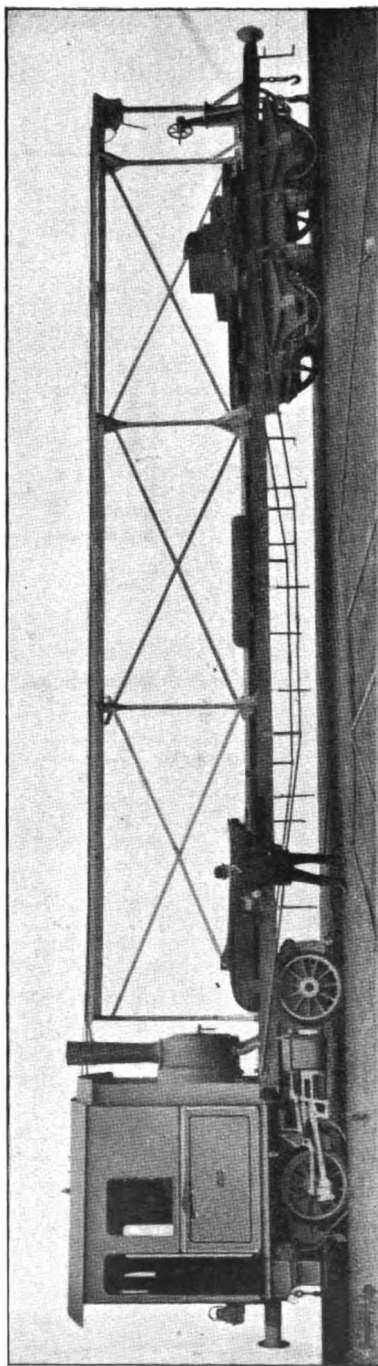
The woodwork of the coach was fitted in India, but the underframe, bogie, all the ironwork fittings, carriage seats, glass, etc., for finishing, were supplied by the Vulcan Foundry, Limited. The engine part may be detached by simply lifting a few inches the front end of the coach. The gear for driving, applying the brake and whistle can be worked from both ends of the coach. In figure 2 will be noticed a temporary erection for these gears, and the picture also shows blocks placed on the carriage underframe to represent the estimated weights of carriage body and passengers.

The vehicle was erected from the designs of Sir Alexander Rendel, and is now being utilized for affording a frequent, a fairly speedy, and an economically worked train service over certain sections of the Indian Northwestern Railway system. It is calculated to maintain a speed of 35 miles per hour.

*Figs. 1 to 5. — Steam motor vehicle for the Indian State Railways.*



**Fig. 1.**



**Fig. 2.**

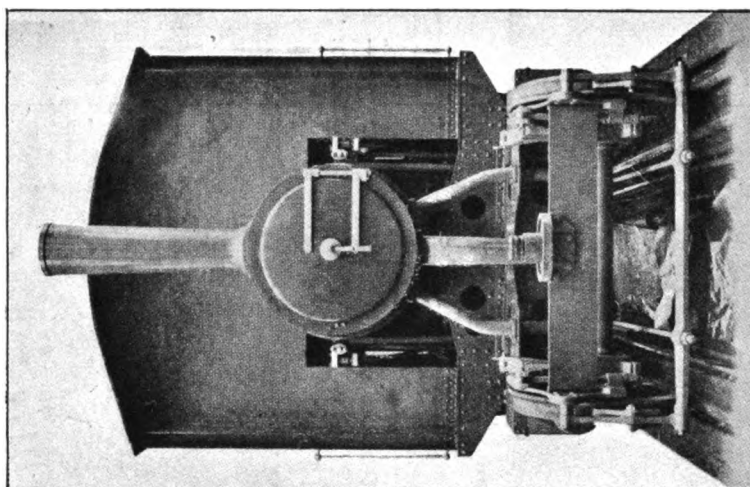


Fig. 5.

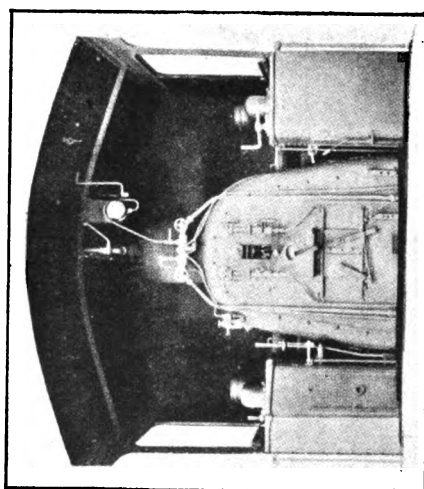


Fig. 4.

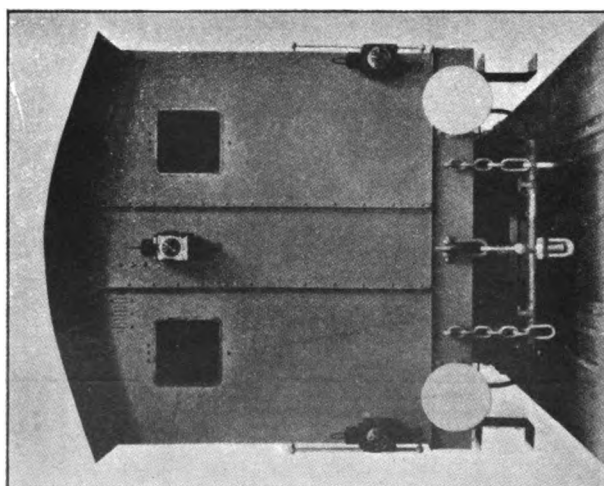


Fig. 3.

The total weight in working order with passengers and luggage is 43.55 tons, of which the locomotive truck carries 25.2 tons and the carriage truck 18.35 tons. The total length over buffer beams is 60 feet and the distance from center to center of trucks is 41 ft. 6 in. The extreme width is 10 ft. 6 in. and the height of stack from the top of the rail is 13 ft. 1  $\frac{3}{4}$  in.

---

[ 621 .132.8 ]

## 2. — Petrol motor for hauling railway carriages.

Figs. 6 to 10, p. 1178 to 1181.

(*Engineering*, abstract.)

The motor in question was constructed by the Wolseley Tool and Motor-Car Company, Limited, of Birmingham, for the General Electric Company, Schenectady, United States of America.

It is intended to drive electric generators for providing current for motors operating railway cars.

The new motor is shown in section in figure 6 and in perspective in figure 7.

The motors have six cylinders, arranged in pairs opposite to each other, and drive a six-throw crank shaft.

The cylinders are 9 inches in diameter, and have a 10 inch stroke.

The cylinders were cast in two pieces: liners and jackets. The joints are metal to metal, and the liners are held in position by studs. The combustion chambers are of cast iron and water-jacketed.

The jacket for the walls of the cylinder is independent from that for the combustion heads; the difficulty of making tight water joints between the two is thus avoided.

The pistons and connecting rods are of specially tough steel, with phosphor bronze bearings, the induction valves are of mild steel, and the exhaust valves have cast iron heads and mild steel stems.

The flywheel weighs 7 cwt., and the half-coupling has been drilled to suit the armature flanges of the generator.

One of the most interesting features is the starting gear. In a previously constructed petrol motor supplied to the North Eastern Railway Company, also used for a railway motor car, an electric generator was used in conjunction with the accumulators to obtain the initial turning movement of the petrol motor; but in this motor the engine is started by the explosion of black powder cartridges.

The cartridge, of ordinary sporting size, contains a charge of 280 to 300 grains of black powder; this is sufficient to give the piston a pressure of about one-half the ordinary working pressure. These cartridges are fired by a special mechanism operated in conjunction with the usual electric ignition gear. Figure 8 shows how the cartridge is placed in position in the breech at the rear end of the cylinder, and figure 9 shows the breech closed and ready for firing.

The diamond shaped casting which carries the usual electric ignition plug, can thus be replaced by a breech-block. This has a cover carrying the trigger mechanism for firing the cartridge; the hook shown in figures 8 and 9 is attached to the trigger. Before starting the engine, this change is effected in three of the six cylinders.

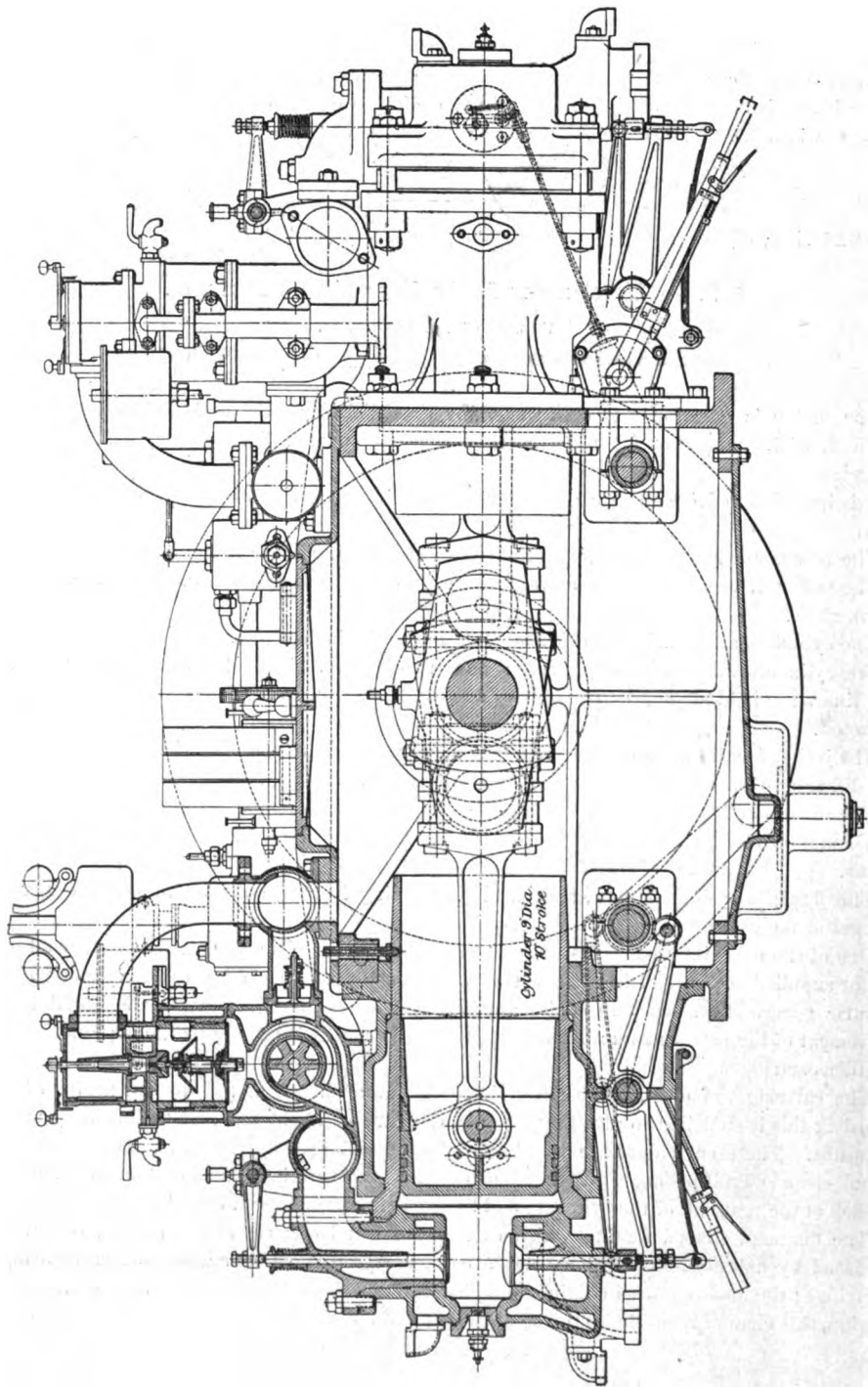


Fig. 6. — Longitudinal section and view.

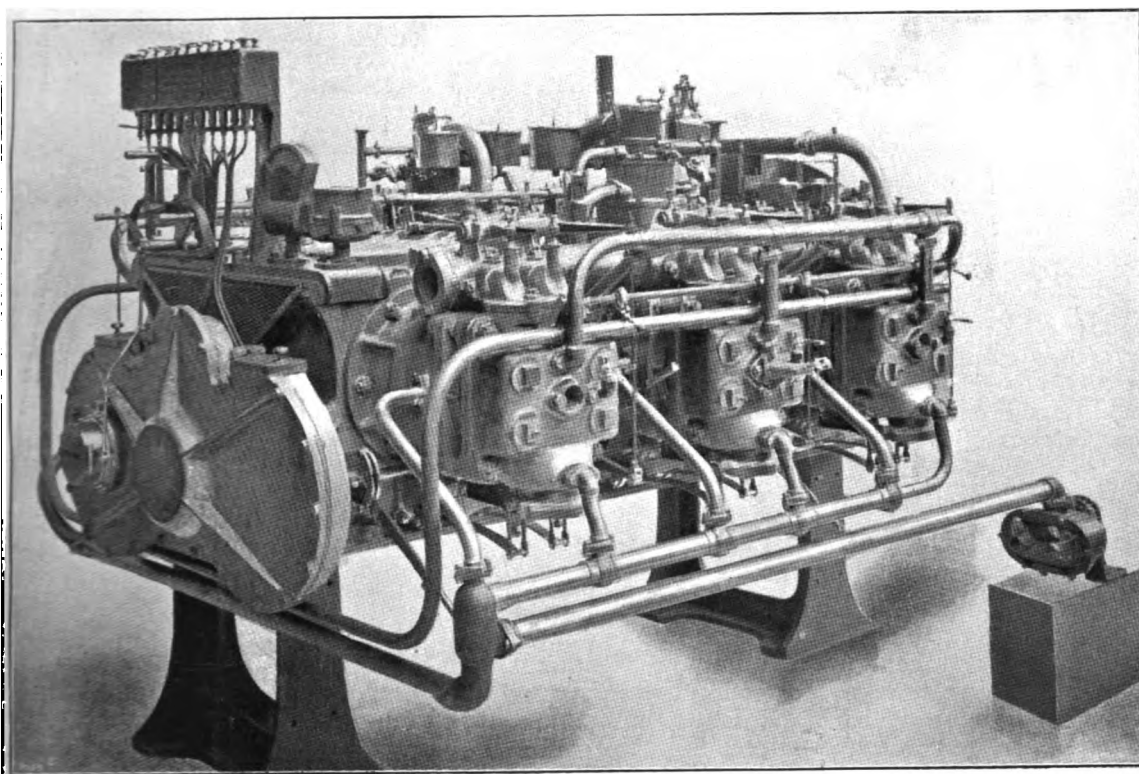


Fig. 7 — General view.

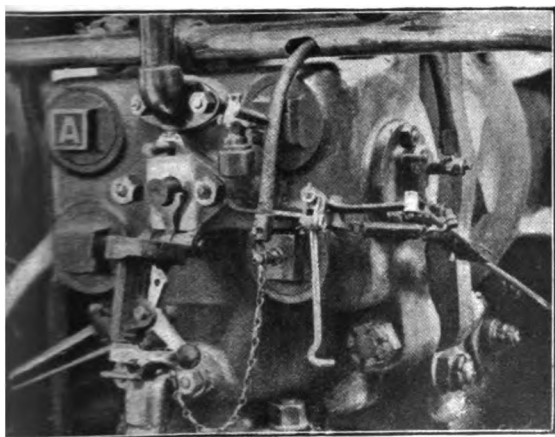


Fig. 8. — Cartridge placed in position.

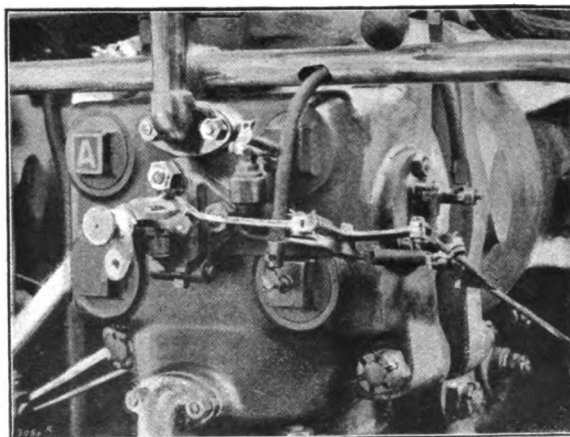


Fig. 9. — Ready for firing.



The cartridge in the first cylinder is fired by hand; the next two cartridges are automatically fired by the movement of the engine. This obviates any such chance of inaccurate timing as might arise if this were done by hand. By the use of the cartridges the engine is started, and while running light, the operator may remove the breech-block and replace it with the ordinary type of ignition.

To ensure the proper working of this system an indicator is necessary to show exactly which cylinder is in position for initially firing by cartridge. For this purpose a dial, figure 10, has been fitted to the top of the casing. An examination of figure 10 will make the working of this indicator sufficiently clear. The disk with six pointers, representing the cylinders, turns in front of a dial divided into four parts : suction, compression, firing, exhaust.

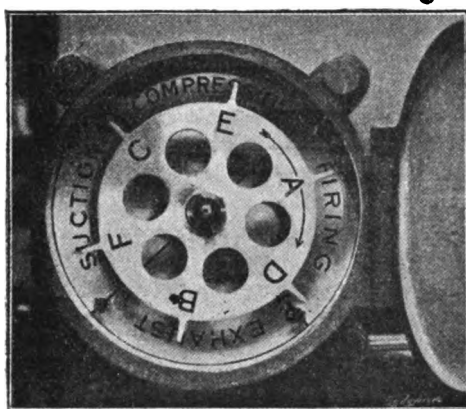


Fig. 10. — Mechanical indicator.

In the figure, cylinder A has stopped during its firing period; the starting must, therefore, be begun with this cylinder.

The starting is carried out as follows : the operator knows, by looking at the indicator just described, which cylinder he has to start from. This and the two succeeding ones have cartridge breech-blocks inserted. A handle operating exhaust valve lifters is then raised, so that any compressed air or gas may escape, as the firing of a cartridge into a compressed space might result in excessive pressure. The cartridges are then inserted; the first one is fired by hand and the two others are fired automatically. The arrangement is simple; the change over from cartridge to the ordinary type of ignition (and *vice versa*) is effected in about three minutes. In the course of a long series of tests, there was not one failure in starting by this means; and in view of the simplicity this new system may probably be substituted for the compressed air starting device.

The three cylinders which start the engine are determined by examining the indicator described above. If there is no cylinder in exactly the right firing position, the engine is "barred" round till one is some 20° past the dead centre on the firing stroke. The other two are then chosen as before. The three remaining cylinders, during the first revolution, suck and compress their charges in the usual way, and take up their firing by means of the high or low

tension magneto. The cylinders with the empty cartridges, immediately after the first cycle, also work in the ordinary way, with low tension magneto ignition. If necessary, the cartridge breech-block can be removed, and the ordinary tension plug carriers inserted in their place. As a rule however the breech-blocks are left in position if the magneto ignition is employed.

The high tension ignition is intended as a stand-by. The contact breaker, which is fixed on the end of the cam shaft, is of the usual Wolseley type; the coil is of the trembler type. The low tension magneto is of the Simms-Bösch type; it has a fixed armature and rotating shield. The igniters are insulated with mica.

Each combustion chamber is fitted with two induction and two exhaust valves. The induction valves are steel forged and of the mushroom type; they are mechanically operated from the cam shaft by means of rockers and pull rods. The air drawn into the carburettor is taken from the crank chamber. This ventilation helps to keep the big ends cool, but the principal idea in view was to draw away any foul gas which might have accumulated in the crank chamber as a result of leakage past the piston rings. Experience on other large size engines has shown that considerable accumulations of bad gas may be found in the crank chamber; the method here adopted has proved quite satisfactory in overcoming this.

The carburettor has a jet through which the petrol is fed by gravity; a float chamber maintains a constant head of fuel. The mixing chamber is closed by a valve; this is opened by the suction of the engine.

As soon as the suction of the engine ceases, the valve closes, and shuts off the supply of explosive gas, which is regulated, as to its proportion of air, by another valve under the direct control of the operator. There are two carburettors. Two float chambers are provided for each carburettor, one being for petrol and the other for petroleum. A three-way cock is provided for changing from petrol to petroleum. This cock is central with the carburettor, and it is operated by a small lever. A second lever enables the air for the carburettor to be sucked from the open atmosphere, or from the crank chamber. A governor operates throttle valves in the mixture pipe.

Force feed lubricating gear is provided.

After successful brake horse-power and starting tests, petrol consumption tests were undertaken. The petrol used on the trials was Anglo-American A, specific gravity 0.700. The total consumption during a non-stop run of three hours was 33 gallons. The average brake horse-power developed during the test was 144.94, so that the consumption per horse-power hour was 0.607 pint. The maximum brake horse-power was 158.24. The temperature of the outflowing cooling water was 45° C. (113° Fahr.).

In the *Street Railway Journal* of February 10, 1903, there appeared a short description of a self-propelled railway car built for the Delaware & Hudson Railway Company, which has an engine similar to the one described above. The car has a driver's compartment at each end; one of these compartments contains the machinery. The external appearance of the body of the car resembles that of a large size bogie-car. During the trials this car ran at an average speed of 64 kilometres (40 miles) per hour; the maximum speed was 75 kilometres (46.6 miles) per hour.

Up till now only isolated trials have been made of explosion motors for railway cars. We can however now record an important advance in this new direction, at all events as far as certain applications are concerned: shunting engines, railway motor cars, etc.

These new applications have been made too recently to make it possible to forecast the success that such applications may have and in what directions they will be extended.

[ 62. (01. (06

### 3. — International Association for testing materials.

(Congress at Brussels in 1906.)

The International Association for testing materials, which was founded at Munich twenty years ago by Professor Bauschinger, made very great progress while the late Louis de Tetmayer, who died in February, 1905, was president; it now has about 2,200 members belonging to all branches of technics, and deals more particularly with the very important problem of standardizing the methods for testing materials used in constructional work.

The Association is quite international in character; it has many members in America, Austria and Hungary, France, Germany and Russia.

Its chief activities are :

1° Bi-weekly bulletins in two or three languages, in which accounts are given of the work of eminent experimentalists such as : Le Châtelier, Martens, Osmond, Mesnager, Schüll, Bélélubsky, Brinell, Howe, Stead, etc.

2° Triennial congresses, where important subjects are discussed, which under the name of problems are dealt with by commissions appointed by the president of the committee at Vienna, and meeting every year in order to discuss and settle questions of an administrative and technical character.

Separate national sections are at work in Paris, Berlin and the United States of America, and their work results in valuable results which are submitted to the International Association itself.

The International Association holds a congress in a different country every three or four years; the 1906 congress will be held at Brussels, under the distinguished patronage of H. M. King Leopold II. His Royal Highness Prince Albert of Belgium is the honorary president.

The meetings will be held at the *Palais des Académies*, September 3 to 8 of this year. The acting presidents will be the ministers of finance and public works, of railways, posts and telegraphs, of war, and of industry and labour. They will deal with the three sections—metals, cement and stone, miscellaneous materials.

Visits will be organized to the chief constructional works in course of erection and to the important industrial centres of Belgium.

#### PROGRAMME OF THE BRUSSELS CONGRESS IN 1906.

*Sunday, September 2.*

The president of the committee will take his seat at 10 a. m., at the *Palais des Académies*.

*Monday September 3.*

General meeting in the morning, at the *Palais des Académies*.

Address by the president of the Association.

Obituary notice on the late president, Louis de Tetmayer, read by Professor Schüll, of Zürich.

Installation of sections : A. Metals; B. Cement and stone; C. Other materials.

In order to dispel any gloomy feelings which may result from the obituary notice on the late

president, papers will be read by Belgian engineers, in French, on the progress of Belgian industries during the last few years.

The afternoon is left unoccupied for a visit to the capital. (Reception at the *Hôtel de ville*.)

*Tuesday, September 4, and Wednesday, September 5.*

In the morning, sectional meetings at the *Palais des Académies*; in the afternoon, visit to the Tervueren and Brussels Port Works, and to the Antwerp (Port) Works.

*Thursday, September 6.*

Final general meeting at the *Palais des Académies*; in the morning, reports by the three sections and concluding address by Mr. Le Châtelier, professor of the *Collège de France*. (Banquet.)

*Friday, September 7.*

Visit to the works of the *Société Cockerill* at Seraing.

*Saturday, September 8.*

Visit to the works at Zee-Brugge, and return via Ostend.



# List of the papers published for the Fifth Session.

ENGLISH EDITIONS (IN RED COVERS).

NUMBER of the pamphlet.	NUMBER of the Question.	TITLE OF THE QUESTION.	CONTENTS.	PRICE.	
				Excluding postage.	Including postage.
1	XX	Brakes for light railways . . . . .	Report, by Mr. Ploeg . . . . .	FR. C. 1 50	FR. C. 1 60
2	V	Boilers, fire-boxes and tubes . . . . .	Addenda, by the same. . . . .	3 "	3 15
3	XVI	Decimal system. . . . .	Report, by Mr. Ed. Sauvage . . . . .	1 50	1 60
4	XIX	Light railway shops . . . . .	— by Mr. J.-L. Wilkinson . . . . .	1 50	1 60
5	XV	The twenty-four hours day. . . . .	— by Mr. Ierzi . . . . .	1 50	1 60
6	XIII	Organisation. . . . .	— by Messrs. Scolari and Rocca. . . . .	1 50	1 60
7	X	Station working . . . . .	2 <sup>nd</sup> report (for English speaking countries), by Mr. Harrison. . . . .	1 50	1 60
8	XI	Signals . . . . .	2 <sup>nd</sup> report on parts A and B (for English speaking countries), by Mr. Turner . . . . .	2 25	2 40
9	I	Strengthening of permanent way in view of increased speed of trains. . . . .	2 <sup>nd</sup> report (for English speaking countries), by Mr. Thompson . . . . .	2 25	2 40
10	VI	Express locomotives . . . . .	1 <sup>st</sup> note, by Mr. Raynar Wilson. . . . .	3 "	3 20
11	II	Places in permanent way requiring special attention. . . . .	2 <sup>nd</sup> report (for English speaking countries), by Mr. William Hunt . . . . .	7 50	7 90
12	XIII	Organisation. . . . .	Addenda by the same. . . . .	1 50	1 60
13	VII	Rolling stock for express trains . . . . .	Report, by Mr. Aspinall. . . . .	9 "	9 40
14	III	Junctions. . . . .	— by Mr. Sabouret . . . . .	2 "	2 10
15	...	The history, organisation and results of the International Railway Congress. . . . .	1 <sup>st</sup> report (for non-English speaking countries), by Mr. Duca . . . . .	3 "	3 15
16	IX	Acceleration of transport of merchandise . . . . .	— by Mr. Zanotta . . . . .	2 50	2 65
17	XII	Cartage and delivery. . . . .	Note, by Mr. A. Dubois . . . . .	1 50	1 60
18	XI (See also N° 8)	Signals . . . . .	Report, by Mr. H. Lambert . . . . .	1 50	1 60
19	XVII-A	Light feeder lines (contributive traffic). . . . .	Report, by Mr. H. Twelveteves . . . . .	3 75	3 95
20	XIV	Settlement of disputes . . . . .	1 <sup>st</sup> note, by the Belgian State Railways Administration. . . . .	1 50	1 60
21	XVIII	The working of light railways by leasing companies. . . . .	2 <sup>nd</sup> note, by the Western Railway of France Administration. . . . .	1 50	1 60
22	IV	Construction and tests of metallic bridges . . . . .	1 <sup>st</sup> Report (for non-English speaking countries), by Mr. Motte. . . . .	3 75	3 95
23	X	Station working. (Methods of accelerating the shunting of trucks.) . . . . .	2 <sup>nd</sup> note, by the Mediterranean Railway Company (Italy). . . . .	1 50	1 60
24	...	Station working. (Employment of mechanical and electrical appliances in shunting.) . . . . .	3 <sup>rd</sup> note, by Mr. Theo.-N. Ely. . . . .	1 50	1 60
25	I	Railway progress in the Dominion of Canada . . . . .	4 <sup>th</sup> — by the American Railway Association (Messrs. A.-W. Sullivan and F.-A. Delano). . . . .	1 50	1 60
26	XVII-B	Strengthening of permanent way in view of increased speed of trains. . . . .	5 <sup>th</sup> note, by Mr. Robert Pitcairn. . . . .	3 75	3 95
27	VIII	Electric traction . . . . .	6 <sup>th</sup> — by Mr. A.-T. Dice. . . . .	1 50	1 60
28	XIV	Settlement of disputes . . . . .	Report, by Mr. De Backer. . . . .	1 50	1 60
29	I	Strengthening of permanent way in view of increased speed of trains. . . . .	— by Mr. De Perl. . . . .	3 75	3 95
30	A	Technical information on the breaking of steel rails. . . . .	— by Mr. de Burlet . . . . .	1 50	1 60
31	B	— on the current cost of metallic compared with wooden sleepers. . . . .	Note, by Mr. W.-M. Acworth. . . . .	4 50	4 75
32	C	Technical information on the life of wooden sleepers of different kinds, not pickled or pickled according to various processes. . . . .	Report, by Mr. Max Edler von Leher. . . . .	6 "	6 30
33	D	Technical information on locomotive crank axles. . . . .	1 <sup>st</sup> report on Part A (for non-English speaking countries), by Mr. J. de Richter . . . . .	1 50	1 60
34	E	— on locomotive fire-boxes. . . . .	1 <sup>st</sup> report on Part B (for non-English speaking countries), by Messrs. Eug. Sartiaux and A. von Boschan. . . . .	3 50	3 70
35	F	— on locomotive boilers. . . . .	1 <sup>st</sup> note, on Part B, by Mr. Ast . . . . .	1 50	1 60
36	G	— on the lubrication of rolling stock. . . . .	2 <sup>nd</sup> — by the Administration of the "Kaiser Ferdinand Nordbahn". . . . .	2 25	2 40
37	H and I	Technical information on shunting engines and on the movement of the staff in different countries. . . . .	Memorandum, by the Hon. Sir Charles Tupper. . . . .	3 "	3 15
38	...	As the information collected on this question was very incomplete, it was not dealt with. . . . .	Report, by Mr. Ast (first part) . . . . .	6 50	6 80
39	...	As the information collected on these questions was very incomplete, it was not dealt with. . . . .	Report, by Messrs. Humphreys-Owen and P.-W. Meik. . . . .	1 50	1 55
40	...	As the information collected on these questions was very incomplete, it was not dealt with. . . . .	1 <sup>st</sup> note, by Mr. E.-A. Ziffer. . . . .	3 50	3 70
41	...	As the information collected on these questions was very incomplete, it was not dealt with. . . . .	2 <sup>nd</sup> — — — — —	1 50	1 55
42	...	As the information collected on these questions was very incomplete, it was not dealt with. . . . .	3 <sup>rd</sup> — by the Hon. Thomas C. Farrer. . . . .	3 50	3 70
43	...	As the information collected on these questions was very incomplete, it was not dealt with. . . . .	Report, by Mr. Auvert . . . . .	3 50	3 70
44	...	As the information collected on these questions was very incomplete, it was not dealt with. . . . .	1 <sup>st</sup> note, by the Western of France Railway. . . . .	3 50	3 70
45	...	As the information collected on these questions was very incomplete, it was not dealt with. . . . .	2 <sup>nd</sup> — by the Northern of France Railway. . . . .	3 50	3 70
46	...	As the information collected on these questions was very incomplete, it was not dealt with. . . . .	3 <sup>rd</sup> — by Mr. Ernest Gerard . . . . .	3 50	3 70
47	...	As the information collected on these questions was very incomplete, it was not dealt with. . . . .	Note, by Mr. Chas. J. Owens. . . . .	3 50	3 70
48	...	As the information collected on these questions was very incomplete, it was not dealt with. . . . .	Report, by Mr. Ast second part. . . . .	3 50	3 70
49	...	As the information collected on these questions was very incomplete, it was not dealt with. . . . .	Report, by Mr. Brucka . . . . .	1 50	1 60
50	...	As the information collected on these questions was very incomplete, it was not dealt with. . . . .	— by Mr. Kowalski . . . . .	3 "	3 15
51	...	As the information collected on these questions was very incomplete, it was not dealt with. . . . .	— by Mr. V. Herzenstein . . . . .	7 "	7 30
52	...	As the information collected on these questions was very incomplete, it was not dealt with. . . . .	As the information collected on this question was very incomplete, it was not dealt with. . . . .	6 "	6 30
53	...	As the information collected on these questions was very incomplete, it was not dealt with. . . . .	Report, by Mr. Hodeige. . . . .	3 50	3 70
54	...	As the information collected on these questions was very incomplete, it was not dealt with. . . . .	— by Mr. Belleröche . . . . .	3 50	3 70
55	...	As the information collected on these questions was very incomplete, it was not dealt with. . . . .	— by Mr. Hubert . . . . .	3 50	3 70

§ 2. — The numbering of the pamphlets (see first col.) issued in French and English is not the same. The English editions are in red covers and the French editions in brown covers.

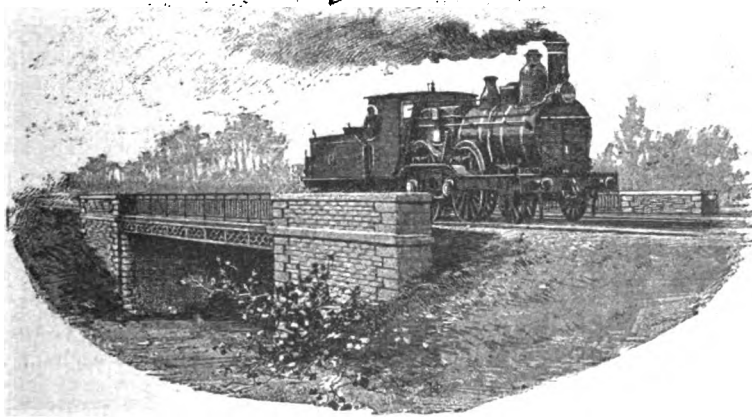
CONTENTS.	PAGES.	NUMBERS OF PLATES AND FIGURES.	NUMBERS of the DECIMAL CLASSIFICATION.
I. — WIRE ropes used in transmissions for operating switches and signals : trials made in order to determine the best specification for such ropes, by Mr. GADOW . . . . .	1041	Figs. 1 to 4, pp. 1043 to 1053.	656 .257
II. — Tests of Westinghouse brakes for fast trains, made on the Bavarian State Railway. (Note communicated by the administration of that railway.) . . . . .	1055	Figs. 1 to 4, pp. 1056 to 1068.	625 .253
III. — SOME remarks on the subject of the Munich trials of fast train brakes, by J. DOYEN . . . . .	1072	...	625 .253
IV. — New armoured pickled wood bedplate, by X. . . . .	1066	Figs. 1 to 6, p. 1068.	625 .143.5
V. — PROCEEDINGS OF THE SEVENTH SESSION (1 <sup>st</sup> section, way and works) :			
Question IV : Concrete and imbedded metal. Sectional discussion. Report of the 1 <sup>st</sup> section. Discussion at the general meeting. Conclusions . . . . .	1071	...	624 .63 & 721 .9
VI. — PROCEEDINGS OF THE SEVENTH SESSION (2 <sup>nd</sup> section, locomotives and rolling stock) :			
Question V : Locomotives of great power. Sectional discussion. Report of the 2 <sup>nd</sup> section. Discussion at the general meeting. Conclusions . . . . .	1097	...	621 .134
VII. — MISCELLANEOUS INFORMATION :			
1. Steam motor vehicle for the Indian State Railways, by F. C. COLEMAN . . . . .	1174	Figs. 1 to 5, pp. 1175 and 1176.	621 .132.8
2. Petrol motor for hauling railway carriages. . . . .	1177	Figs. 6 to 10, pp. 1178 to 1181.	621 .132.8
3. International Association for testing materials. (Congress at Brussels in 1906.) . . . . .	1183	...	62. (01. (06
VIII. — MONTHLY BIBLIOGRAPHY OF RAILWAYS :			
I. Bibliography of books . . . . .	65	...	016 .365. (02
II. — of periodicals . . . . .	68	...	016 .365. (06

EARLY SUBSCRIPTION (Jan. to Dec. only) PAYABLE IN ADVANCE, £1.4s. = \$6.

Vol. XX. — No. 8. — August, 1906.

11<sup>th</sup> Year of the English Edition.

**BULLETIN**  
OF THE  
**INTERNATIONAL RAILWAY CONGRESS**  
ASSOCIATION  
(ENGLISH EDITION)  
[ 385. (05) ]



Editorial communications should be addressed  
to the Permanent Commission (Executive Committee) of the International Railway Congress Association  
rue de Louvain, 41, Brussels.

**BRUSSELS**  
PUBLISHED BY P. WEISSENBRUCH, PRINTER TO THE KING  
49, rue du Poinçon.

**LONDON**  
P. S. KING AND SON, PARLIAMENTARY AND GENERAL BOOKSELLERS  
2 and 4, Great Smith Street, Westminster, S. W.

The Permanent Commission of the Association is not responsible for the opinions expressed  
in the articles published in the BULLETIN.

# NOTICE

---

All editorial communications intended for the *Bulletin* should be addressed to Mr. Louis Weissenbruch, General Secretary of the Permanent Committee, International Railway Congress Association, 11, rue de Louvain, Brussels. The *Bulletin*, which is published in monthly numbers forming an annual volume of more than 800 pages, contains the whole of the proceedings and publications of the Congress of every kind. Copies are sent gratuitously to all the Companies, members of the Congress, at the rate of one copy for each delegate which the Company is entitled to send to a Congress meeting with one extra copy for the Company's own library.

The *Bulletin* can be supplied at the rate of 25 francs = £1 = \$5 per annum, not including postage; or 30 francs = £1.4s. = \$6 including postage to subscribers who send their subscriptions in advance by cheque or postal order direct to the publisher, Paul Weissenbruch, 49, rue du Poinçon, Brussels.

---

*N. B.* — The annual subscription, which must be paid in advance and dates from the January of the year for which the subscription is sent, does not vary even when the number of pages in the year's issue greatly exceeds 800 pages (the 1900 volume of the English edition consisted of 3988 pages). But the price of each monthly number, if bought separately, is fixed according to the number of pages it contains as follows:

2s. (50 cents) per 72 pages not including postage.

It is therefore evident that there is a great gain in subscribing for the whole year.

---

The whole years 1896, 1897, 1898, 1899, 1900, 1901, 1902, 1903, 1904 and 1905 of the English edition of the *Bulletin* containing 1,370, 1,824, 1,634, 1,695, 3,988, 2,734, 1,129, 1,353, 2,066 and 2,626 pages, may be obtained each at 35 francs = £1.8s. = \$7, including postage.

---

Previous volumes of the *Bulletin*, published in French only, contained 1,574, 1,196, 2,194, 1,576, 749, 4,114, 1,124, 1,118, 3,812 and 1,632 pages, illustrated with numerous plates and diagrams, for the years 1887 to 1896 respectively may be obtained at the same price.

---

PAPERS PUBLISHED FOR THE FIFTH SESSION : A detailed list of the papers, notes, and technical information, prepared for the London meeting, is given on the third page of the cover.

Copies may be had on application to the publisher, 49, rue du Poinçon, enclosing remittance of the price as given in the list opposite each paper on the third page of the cover. (*N. B.* 1 franc = 10d. = 20 cents.)

BULLETIN  
OF THE  
INTERNATIONAL RAILWAY CONGRESS  
ASSOCIATION  
(ENGLISH EDITION)

---

[ 621 .133 (01) ]

NOTE  
ON THE STEAM PRODUCTION OF LOCOMOTIVE BOILERS,

By O. BUSSE,

LOCOMOTIVE AND ROLLING STOCK SUPERINTENDENT, DANISH STATE RAILWAYS.

---

In an article published in the *Bulletin of the Railway Congress* for April 1906, entitled "Note on the calculation of the loads hauled by locomotives and on the determination of the time required for running on ordinary service", I used, in order to calculate the steam production of a locomotive boiler, the equations which I had laid down in the *Organ* for 1880, page 16. This article had previously appeared in the *Organ* 1905, pp. 123 *et seq.* A little later, an article appeared in the *Zeitschrift des Vereins deutscher Ingenieure*, 1905, page 717, by Mr. Strahl, railway engineer, in which the amount of water evaporated in a boiler is determined from thermodynamic data. This question was of much interest to me, and I examined his results in order to see to what extent they agreed with my old equations, which were based on experimental data. Taking a performance such as given by our most usual type of boiler, type K, and assuming the amount of water evaporated to be that given by the old equation, the new theory gives a somewhat lower value for the small boilers evaporating about 2,500 litres (5,500 lb.) per hour, whereas it gives a higher value to the new boilers, which evaporate 8,000 to 9,000 litres (17,630 to 19,840 lb.) per hour. My long experience leads me to conclude that these results are more accurate with the smaller boilers, for, if the latter are examined after they have been used, they show that they have no doubt been subjected to greater comparative fatigue than the larger ones. Moreover, trials made with large recent boilers have given higher figures than those calculated from my old equations.

The calculation on Mr. Strahl's method is however somewhat complicated, and I asked one of the younger engineers of our railway to give it another shape, making

various assumptions and abbreviations, so that the evaporation can be calculated from the grate area  $R$ , the fire-box heating surface  $H_f$ , and the smoke tube heating surface  $H_r$ , all measured internally.

The water evaporated per hour,  $W$  litres, then becomes :

$$W = H_f \frac{12 - \frac{H_f}{R}}{0.025} + H_r \frac{\left(36 - \frac{H_f}{R}\right) \left(150 - \frac{H_r}{R}\right)}{100},$$

or, substituting for  $\frac{H_f}{R}$  the fixed coefficient 5, we get

$$W = 40 \times H_f \left(12 - \frac{H_f}{R}\right) + 0.31 \times H_r \left(150 - \frac{H_r}{R}\right).$$

In our type K boilers, where

$$R = 1.77, H_f = 9.25, H_r = 78.76,$$

we get :

$$W = 40 \times 9.25 \left(12 - \frac{9.25}{1.77}\right) + 0.31 \times 78.76 \left(150 - \frac{78.76}{1.77}\right),$$

or

$$W = 2,506 + 2,574 = 5,080 \text{ kilograms (11,199 lb.)},$$

whereas the old equation gave :

$$W = 5,047 \text{ kilograms (11,127 lb.)}.$$

In the newer boilers, of type P, we have :

$$R = 3.23, H_f = 12.4, H_r = 192.4;$$

this gives :

$$W = 40 \times 12.4 \left(12 - \frac{12.4}{3.23}\right) + 0.31 \times 192.4 \left(150 - \frac{192.4}{3.23}\right),$$

or

$$W = 3,995 + 5,394 = 9,389 \text{ kilograms (20,699 lb.)},$$

whereas my old equation only gave 8,430 kilograms (18,585 lb.).

Per square metre of total heating surface,

$$W_1 = 41.2,$$

whereas, according to the new formula :

$$W_1 = 45.9.$$

In these formulæ, the first term of the second expression represents the evaporation due to the fire-box; the second that due to the tubes. It is worth noticing how much of the evaporation is due to direct heating surface; in type K this is 49 per cent of the total and is thus much greater than was assumed formerly.

One particular point is that this new theory in no way considers the ratio of length to diameter of tubes. It was always believed, and all the trials made on our lines, with boilers some of which, other dimensions being equal, had fewer tubes but larger ones, others more tubes but smaller ones, confirmed the fact that in spite of a smaller total heating surface, the larger tubes evaporated more water. The probable explanation of this fact lies in the greater fatigue and the reduction in economy. Although no conclusive evidence on the subject is available, it seems certain that in actual working a locomotive with a smaller smoke-tube heating surface gives a better result.

As a summary, we may state that in calculations of this kind it is not intended to attain accuracy, but only to obtain figures giving the approximate mean values to be obtained in railway practice. This object is undoubtedly attained by the formula given above. Moreover, it is simple and clear, and its general use may hence be recommended.

---

# TABLE OF SPEEDS

By HENRI DE SARRAUTON.

Figs. 1 and 2, p. 1188.

This table may be used with advantage in conjunction with the decimal chronograph measuring twenty-thousandths of an hour, or halves of decimal seconds. Its principal object is the solution of the problem, which continually turns up in connection with sport, namely, what is the speed per hour? It is for this reason that it has been reduced to a pocket book size, so that it may become the vademecum of sportsmen and of drivers on railways.

It solves at sight or by a simple interpolation the following general problem :

A unit of work having been produced in a given decimal fraction of an hour, to find the work produced per hour.

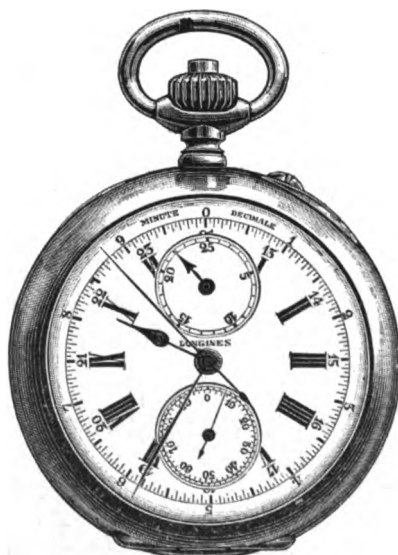


Fig. 1. — Decimal chronograph.  
The time recorded is 22 (decimal) minutes  
88 seconds, or 0.2288 hour.

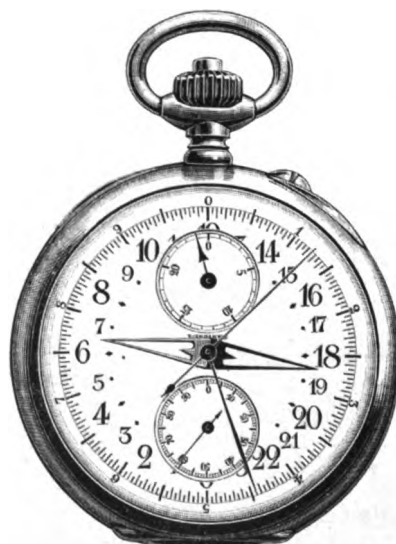


Fig. 2. — Decimal chronograph.  
The time recorded is 24 (decimal) minutes  
12 seconds 50 quarts, or 0.241250 hour.



**Rule.** — When the given number of decimal seconds is not to be found in the table, then for the purposes of interpolation take the next highest number **S**, and add to the corresponding number **M** the product of **d** multiplied by the difference between **S** and the given number.

**Example 1.** — A motor car covered 1 kilometre (0·621 mile) in 127·5 decimal seconds (0·01275 hour). What was the speed per hour?

By referring to numbers 128 and 127 in the table, we see by inspection that the required speed is approximately 78·4 (48·7 miles). Such an approximation is generally all that is required. In order to obtain a more accurate result, we must apply the rule :

$$\begin{array}{rcl} \text{The table gives for 128} & . & . & . & . & . & 78\cdot125 \\ 0\cdot5 \times 615 & . & . & . & . & . & = & \underline{307} \\ & & & & & & 78\cdot432 \text{ (48\cdot736 miles).} \end{array}$$

**Example 2.** — A tap supplies 10 litres (2·201 English gallons) of water in 443·5 decimal seconds (0·04435 hour). How much will it supply per hour?

$$\begin{array}{rcl} \text{The table gives for 445.} & . & . & . & . & . & . & 22\cdot472 \\ 1\cdot5 \times 51 & . & . & . & . & . & . & = & \underline{76} \\ & & & & & & & 22\cdot548 \end{array}$$

Multiplying this by 10, we obtain 225·48 litres (49·627 English gallons).

**Example 3.** — A locomotive covered 4 kilometres (2·486 miles) in 391·5 decimal seconds. What was the speed per hour?

$$\begin{array}{rcl} 391\cdot5 : 4 = 97\cdot875. \\ \text{The table gives for 980.} & . & . & . & . & . & . & 10\cdot204 \\ 1\cdot25 \times 10\cdot4 & . & . & . & . & . & . & = & \underline{13} \\ & & & & & & & 10\cdot217 \end{array}$$

Multiplying this by 10, we obtain 102·17 kilometres (63·49 miles).

We might operate differently : assume that the locomotive has run 1 kilometre (0·621 mile) in 391·5 decimal seconds and multiply the result by 4.

The few figures given at the end of the speed table make it possible to use it with an ordinary chronograph by converting the sexagesimal seconds (S) into decimal seconds (s).

In order to convert the sexagesimal figures into decimals, it is necessary in the first place to reduce the minutes to seconds. Then all that is required is to write down and add the figures given in the conversion table.

**Example 4.** — A trotting horse covers 1 kilometre (0·621 mile) in 2 minutes 27·4 seconds. What is the speed per hour?

Now 2 minutes 27·4 seconds = 147·4 seconds.

100s	277·778
40s	111·111
7s	19·444
0s4	1·111
	<hr/> 409·444

The table gives for 410	24·390
0·56 × 60·2	= 34

Speed of trotting. . . = 24·424 (15·177 miles).

As the differences shown in the third column of the speed table increase very quickly, the interpolation of half a decimal second gives a result which is a little too high. The error is however very small as it is always less than  $\frac{3}{100,000}$ . It can however be made to vanish by applying Newton's method, and subtracting from the result  $\frac{1}{8}$  of the second difference.

The speed table can equally well be applied in the case of English units. The second column then gives miles and thousandths instead of metres.

*Example 5.* — A motor car can run 1 mile in 114·5 decimal seconds. What was the speed per hour?

The table gives for 115.	86·957
0·5 × 762	= 381
	<hr/> 87·338
$\frac{1}{8} (777 - 762)$ .	= 2
Exact speed.	<hr/> 87·336

To reduce thousandths of a mile to yards is very easy once we have made a table of the first nine multiples of 1,760 :

1 . . .	1 760	6 . . .	10 560
2 . . .	3 520	7 . . .	12 320
3 . . .	5 280	8 . . .	14 080
4 . . .	7 040	9 . . .	15 840
		5 . . .	8 800

Thus :

0·3	528
0·03	52·8
0·006.	10·6
	<hr/> 591·4

The speed of the motor car is thus 87 miles 591 yards per hour.

# NOTE

## ON THE METAL SCREW BUSHES FOR STRENGTHENING RAIL FASTENINGS, ON THE THIOLLIER SYSTEM <sup>(1)</sup>,

By X<sup>\*\*\*</sup>

Figs. 1 to 7, pp. 1193 to 1201.

Mr. J. Thiollier's metal screw bush consists of a steel helix (fig. 1) of oval section, with a number of turns depending on the pitch and length of the screwspike; this is driven into a female thread cut in the sleeper, by means of a sharp tap, at the spot where the screwspike is going to be placed. The bush has the same pitch as the screwspike which is going to be used, and its internal diameter is practically the same as the core diameter of the screwspike, so as to reduce the play between them to a minimum. When the bush is in place, its upper end is flush with the seat cut on the sleeper; below its lower end there must be at least 1 centimetre ( $\frac{3}{8}$  inch) of wood left.



Fig. 1.

The following phenomena are observed if the screwspike securing the Vignoles rail or the chair to the sleeper is tightened, when such a bush is used in wood with weak or damaged fibre :

The screwspike at first turns without requiring more force than what is necessary for overcoming the small amount of friction between the threads and the bush, the threads having previously been tarred.

As soon as tightening begins, when the head of the screwspike comes into contact with the rail or the chair, the bush expands, pressing against the sides and adjusting itself to the shape of the screwspike; this prevents the latter from working loose, and the helix acts as a spring, the different turns all being affected by the stress produced, parallel to its axis, by the screwspike.

As the bush has a greater diameter than the screwspike, it is supported by a greater surface of wood than the screwspike if used by itself; and when sleepers are used over again, the screwspike being used at the same place as before, the bush is in contact with less weakened or damaged wood.

Moreover the bush works elastically, each of the turns of the spring separately; whereas a screwspike if over-turned or if it draws, at once breaks away or destroys the wood in contact with all the turns of the thread.

<sup>(1)</sup> Descriptions of this system have appeared in the *Revue générale des chemins de fer*, January, 1904, in Auguste Moreau's *Traité des chemins de fer*, part 10, in the *Zeitschrift des österreichischen Ingenieur- und Architekten Vereines*, March 23, 1906, etc.

These statements have all been verified by the following experiments on drawing spikes, which were made either with the apparatus described in the *Revue générale* for September, 1899, or with a special hydraulic appliance devised by Mr. Thiollier <sup>(1)</sup>.

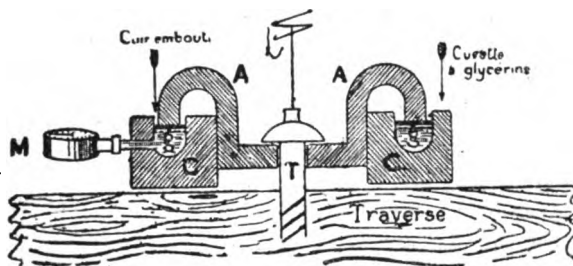


Fig. 2.

*Explanation of French terms :* Cuiv. embouti = Flanged copper. — Traverse = Sleeper.  
Cuvette à glycerine = Trough containing glycerine.

The trials and observations made on the French Western Railway are shown in the following table.

KIND OF SLEEPER.	POSITION OF SCREWSPIKE.	FORCE REQUIRED TO DRAW SCREWSPIKE		COMPRES- SIVE FORCE WHEN TIGHTENING UP.	Remarks.
		alone.	with bush.		
1° Doaty oak sleeper (a, b) . . . . .	Outside (over-turned).	1,800 kilog. (3,968 lb.)	3,200 kg. (7,055 lb.)	...	a) Two screwspiques, one inside and one out- side, out of three, over- turned; pitch 12.5 milli- metres (1/2 inch). b) After drawing, the screwspiques put back into place in the lining did not become over-turned.
	Inside (over-turned).	800 kilog. (1,764 lb.)			
2° Cracked beech sleeper (c). . . . .	Near the crack.	500 kilog. (1,102 lb.)	2,000 kg. (4,409 lb.)	4,200 kilog. (9,260 lb.)	c) Easily became over- turned.
	In sound wood.	5,000 kilog. (12,125 lb.)	First drawing : 6,800 kg. (14,990 lb.)	...	
			Second drawing : 6,800 kg. (14,990 lb.)	...	
3° New pine sleeper, in use on the main line for four years (d, e) . . . . .	Over-turned.	1,200 kilog. (2,645 lb.)	6,000 kg. (13,228 lb.)	...	Bush with 8 1/2 turns. d) Two screwspiques out of three, over-turned. e) As b above.
	Not over-turned.	1,700 kilog. (3,748 lb.)	6,200 kg. (13,669 lb.)	...	
		1,200 kilog. (2,645 lb.); wood affected.	2,800 kg. (6,173 lb.)	3,800 kilog. (8,378 lb.)	
4° Fir sleeper used on sidings (f). . . . .	Over-turned.	1,700 kilog. (3,748 lb.); wood sound			f) Screwspike overturn- ed.

(1) This appliance, shown diagrammatically in figure 2, consists essentially of a trough CC filled with

These results led the French Western Railway to extend the use of these bushes. In 1902, they first came into regular use; by now there are more than 550,000 such bushes in use on that line.

#### METHOD OF PUTTING IN THE BUSHES.

Putting in these bushes involves the following operations, it being assumed that the holes for the ordinary screwspikes have already been bored and cleaned out :

*1° Cutting, by means of a special tap (fig. 3), the female thread for the bush.*

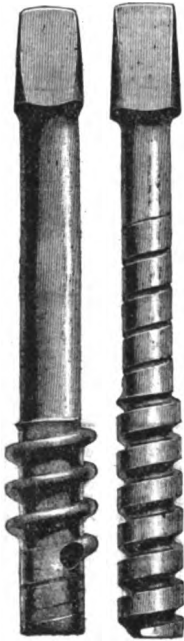


Fig. 3.  
Tap.

Fig. 4.  
Driver.

The thread for the bush is cut by means of a special tap, having a plug end of the same diameter as the hole, which acts as guide.

This tap must be well lubricated before it is used; if, while it is used, it tends to seize, it must be taken out, and carefully cleaned. The hole must also be cleaned, and the tap entered again, care being taken to strike the same thread.

The thread can be cut by a single tap in soft wood; in hard wood two taps are used in succession. The thread must be cut of a length equal to that of the bush. If the sleeper is not thick enough for the bushes provided, it may be necessary to cut part of the bushes off.

*2° Putting in the bush.*

In order to screw the bush into the sleeper, it is first screwed, after greasing, on to a threaded driver (fig. 4). By means of this it is driven home into the female thread which has been tapped.

It may happen :

a) That the bush only enters a short way and then slips on the driver, the last turn being slightly out of true and open, so that it does not properly fit the thread cut. In this case, it must be taken out altogether by replacing the driver by a rusty screwspike which seizes on the bush and enables the two to be removed together. Another bush is then put in, care being taken to select one with its last turn true.

b) That the upper end of the bush, although the bush has been driven right home, projects above the seating. In this case, the part which projects is cut off either by means of special shears, or more simply by means of a three-square file.

When the bushes are in, the base of the rail or of the chair is fixed by screwspikes introduced

---

glycerine (gg), with a circular cover AA having in the middle a hole through which the screwspike T passes. The edge of this cover presses, by means of a flanged copper ring, on the glycerine; the pressure on the glycerine is read on the pressure gauge M, and thus the force exerted by the screwspike is determined.

into the holes and then tightened right up; the operation is just the same, with both Vignoles rails and chairs, as if screwspikes alone were used.

In work out on the open track, if the gauge of the track is satisfactory and the existing screwspike holes are in the right position, these holes themselves are threaded direct and the bushes put in.

If not, then the position of the screwspike holes are determined by the usual methods adopted in revision work; and this gives the position of the bushes (*see* means for correcting widening of gauge, in the list, given below, of the chief uses of these bushes).

The practical trial of five years of use, as well as all the observations made and referred to above tend to show (subject to further information more prolonged trials may yield) that the Thiollier bush has the following merits :

The tools required are few in number, simple and inexpensive ;

The men soon learn their use ;

Because little force is required to work the tools, the men like them ;

They are easy to use, even on lines where there is much traffic ;

Taking out and replacing the screwspikes does not damage the wood; no precautions are necessary ;

It makes it impossible to hammer the screwspikes in ;

The wood of the sleeper is not weakened ;

A screwspike can be put in at the same place where it no longer held without the bush. As thus more room is available for the location of screwspikes it becomes unnecessary to plug numerous holes; the latter operation often results in splitting the sleepers ;

It is possible, if necessary, to have the screwspike where there is a small shake ;

It makes it possible to use over again screwspikes with the thread somewhat rusted ;

Soft wood can be used more extensively ;

Sleepers which otherwise could no longer be used can be used over again.

As for disadvantages or difficulties, the following may turn up :

The presence of a metal substance, although easy to see, at a surface which is adzed; so that a man, if not warned, may damage his adze ;

When the bushes are put in by an unskilful man, the last turn may become opened out. This makes it necessary to take out the bush and replace it by another ;

Finally, it is necessary to have at least 1 centimetre ( $\frac{3}{8}$  inch) of wood below the lower end of the bush; this requires a little care on the part of the man doing the work.

#### APPROXIMATE NET COST.

The net cost of the bushes, put in place, is an important factor as regards their use.

The first cost of the bushes varies with the size of the screwspike. It is as follows for the more usual types :

SCREWSPIKES		LENGTH OF BUSH.	NUMBER OF TURNS.	WEIGHT.	COST AT WORKS IN QUANTITY (80 to 90 francs per 100 kilograms [£1.9s. to £1.13s. per 100 lb.]).
pitch.	diameter of core.				
12.5 millimetres ( $\frac{1}{2}$ inch).	16.5 millimetres ( $\frac{21}{32}$ inch).	110 millimetres (4 $\frac{5}{16}$ inches).	9	0.158 kilogram (0.348 lb.).	0.12 to 0.14 franc (1.15 to 1.34 pence).
12.5 millimetres ( $\frac{1}{2}$ inch).	14 millimetres ( $\frac{25}{64}$ inch).	100 millimetres (4 inches).	8 $\frac{1}{2}$	0.140 kilogram (0.309 lb.).	0.11 to 0.12 franc (1.06 to 1.15 pence).
12.5 millimetres ( $\frac{1}{2}$ inch).	14 millimetres ( $\frac{25}{64}$ inch).	81 millimetres (3 $\frac{1}{16}$ inches).	6 $\frac{1}{2}$	0.109 kilogram (0.240 lb.).	0.085 to 0.09 franc (0.82 to 0.86 pence).
10 millimetres ( $\frac{3}{8}$ inch).	15 millimetres ( $\frac{19}{32}$ inch).	100 millimetres (4 inches).	10	0.135 kilogram (0.298 lb.).	0.12 to 0.14 franc (1.15 to 1.34 pence).

The time required for putting in the bush varies according to conditions. The average is :

At a separate workshop, not on the track, one tapping being required : in fir or pine, 2 to 2  $\frac{1}{2}$  minutes per man; in oak or beech, 3 to 3  $\frac{1}{2}$  minutes per man.

Out on the track, with two successive tapplings required in order to get rid of all the shavings : 3 to 3  $\frac{1}{2}$  minutes per man, whatever the kind of wood.

Given these particulars, it is easy to determine the net cost per bush in place.

We may add that this bush makes it possible to substitute screwspikes for dogspikes (the latter have little strength, but are still used in some countries), and that in the same holes, without trouble to the platelayer and at a very low cost.

#### Results obtained in the French Eastern shops.

The result obtained is that if the same amount of tightening is used with a screwspike alone,

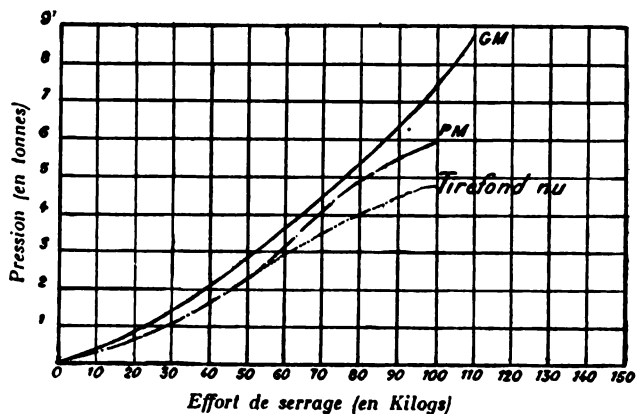


Fig. 5. — Curve No. 1. — Oak.

Eastern Railway screwspike; outside diameter, 25 millimetres ( $\frac{21}{32}$  inch); core diameter, 16.5 millimetres ( $\frac{21}{32}$  inch); pitch, 12.5 millimetres ( $\frac{1}{2}$  inch).

Explanation of French terms : Effort de serrage (en kilogs) = Force acting on wrench (kilograms).  
Pression (en tonnes) = Pressure (in tons). — Tirefond nu = Screwspike by itself.

and with a screwspike with a bush, the useful effect obtained in the latter case may amount to

double that in the former, if large pattern bushes and hard wood are used. In the course of trial, the pressure increases very nearly proportionally to the force, until the moment where the core of the screwspike receives a permanent set owing to the limit of elasticity being exceeded. With a screwspike used alone, the wooden thread, being weaker, would strip long before this result could be attained. Curves 1 and 2 (figs. 5 and 6) show the results of tests made under these conditions, one in oak, the other in fir. The forces applied to the wrench are plotted as abscissæ and the corresponding pressures as ordinates.

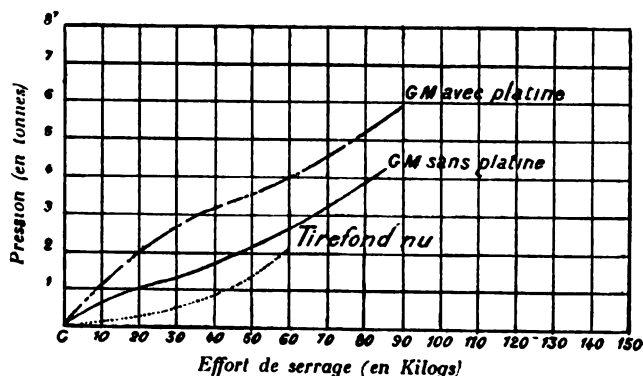


Fig. 6. — Curve No. 2. — Fir.

Same screwspikes as in curve No. 1.

*Explanation of French terms :* Effort de serrage (en kilogs) = Force acting on wrench (kilograms). — Pression (en tonnes) = Pressure (in tons). — Tirefond nu = Screwspike by itself. — Avec platine = With bedplate. — Sans platine = Without bedplate.

Tables A and B give a summary of the results of these tests.

TABLE A. — Spikes drawn by continuous pull.

FASTENING USED.	FIR.	OAK.	BEECH.	Remarks.
22 millimetre ( $\frac{29}{32}$ inch) French Eastern screwspike, pitch, 12.5 millimetres ( $\frac{1}{2}$ inch); core diameter, 16.5 millimetres ( $\frac{21}{32}$ inch):				
1° Screwspike by itself . . . . .	2,700 kilog. (5,952 lb.).	6,200 kilog. (13,669 lb.).	6,800 kilog. (14,991 lb.).	The maximum power of the testing plant was 8,000 kilograms (17,637 lb.).
2° — and bush, medium pattern . .	4,600 kilog. (10,141 lb.).	7,400 kilog. (16,314 lb.).	Over 8,000 kilog. (Over 17,637 lb.).	
3° — — large pattern . . .	4,700 kilog. (10,362 lb.).	7,500 kilog. (16,535 lb.).	Over 8,000 kilog. (Over 17,637 lb.).	

TABLE B. — *Spikes drawn by successive pulls.*

FASTENING USED.	FIR.	RISING OF SCREWSPIKE.	OAK.	RISING OF SCREWSPIKE.	Remarks.
23 millimetre ( $\frac{20}{32}$ inch) French Eastern screwspike, pitch, 12.5 millimetres ( $\frac{1}{2}$ inch); core diameter, 16 millimetres ( $\frac{5}{16}$ inch);					
First application . . . . .	4,600 kg. (10,141 lb.).	8 millimetres ( $\frac{5}{16}$ inch).	7,400 kg. (16,314 lb.).	6 millimetres ( $\frac{1}{4}$ inch).	As the resistance of beech was greater than the maximum power of the apparatus, it was not possible to make tests with this wood.
Second application . . . . .	4,300 kg. (9,480 lb.).	8 millimetres ( $\frac{5}{16}$ inch).	6,700 kg. (14,771 lb.).	6 millimetres ( $\frac{1}{4}$ inch).	
Third application . . . . .	3,200 kg. (7,055 lb.).	8 millimetres ( $\frac{5}{16}$ inch).	6,500 kg. (14,330 lb.).	6 millimetres ( $\frac{1}{4}$ inch).	

TABLE C. — *Force required to over-turn the screwspikes.*

FASTENING USED.	FIR.	OAK.	BEECH.	Remarks.
23 millimetre ( $\frac{20}{32}$ inch) French Eastern screwspike, pitch, 12.5 millimetres ( $\frac{1}{2}$ inch); core diameter, 16.5 millimetres ( $\frac{21}{32}$ inch);				
Without bush. . . . .	50 kg. (110 lb.).	120 kilog. (265 lb.).	120 kilog. (265 lb.).	We consider a pull of 150 kilograms (330 lb.) as one considerably greater than two men can give in ordinary daily work. The ordinary pull is 80 kilograms (176 lb.).
Screwspike and bush, large pattern.	115 kg. (254 lb.).	Over 150 kilog. (Over 330 lb.).	Over 150 kilog. (Over 330 lb.).	

#### COMPARATIVE RESISTANCE TO OVER-TURNING.

(Trials made in the Paris-Lyons-Mediterranean workshops at Bourg [Ain]).

*Screwspike, by itself, in Landes pine* : The screwspikes over-turn, the wood thread stripping, as soon as a force of 80 kilograms (176 lb.) is applied at the end of a lever 60 centimetres (2 feet) long.

*Screwspike in thread cut in hard wood* :

At 50 kilograms (110 lb.) . . . . . 1 screwspike over-turns.  
 At 80 — (176 —) . . . . . 38 screwspikes over-turn.  
 At 100 — (220 —) . . . . . All the other screwspikes over-turn.

*Screwspike and metal bush (bush of current type, made of 8 by 4 millimetre [ $\frac{5}{16}$  by  $\frac{5}{32}$  inch] wire)* : Not a single screwspike over-turns when a force of 125 kilograms (276 lb.) acts on the wrench; the screwspikes stretch as the 14 millimetre ( $\frac{35}{64}$  inch) core cannot resist the application of this force without permanent deformation.

#### RESISTANCE TO CREEPING.

(Trials made in the Paris-Lyons-Mediterranean workshops at Bourg [Ain]).

In pine wood, after the screwspike had been driven in by a force of 60 kilograms (132 lb.) applied at the end of a lever 60 centimetres (2 feet) long :

Screwspike by itself. . . . . 1,500 kilograms (3,307 lb.).  
 — in a thread cut in hard wood. . . . . 4,500 — (9,920 —).  
 — with bush of 8 by 4 millimetre ( $\frac{5}{16}$  by  $\frac{5}{32}$  inch) wire . . . 6,000 — (13,228 —).

# ELASTICITY OF THE FASTENING.

(Paris workshops.)

A screwspike by itself driven into oak by a force of 80 kilograms (176 lb.) applied at the end of a lever 60 centimetres (2 feet) long, exercises a pressure of 4,000 kilograms (8,818 lb.). If slackened half a millimetre ( $\frac{1}{64}$  inch) it no longer gives any pressure.

With a screwspike and bush, giving a pressure of 6,000 kilograms (13,228 lb.), the following results were obtained :

After slackening 0.5 millimetre ( $\frac{1}{64}$ inch) pressure.	5,000 kilograms (11,023 lb.).
— — 1.0 — ( $\frac{2}{64}$ —) — . . .	3,500 — (7,716 —).
— — 1.5 — ( $\frac{1}{16}$ —) — . . .	2,500 — (5,512 —).
— — 2.0 millimetres ( $\frac{5}{64}$ —) — . . .	1,500 — (3,307 —).
— — 2.5 — ( $\frac{3}{32}$ —) — . . .	1,000 — (2,205 —).
— — 3.0 — ( $\frac{1}{8}$ —) — . . .	250 — (551 —).

## Trial of drawing the screwspike by jerking.

The result of this trial cannot be given in figures. Mr. Thiollier proceeded as follows : the claw of a claw-ended pinchbar, from 1.5 to 2 metres length (4 ft. 11 in. to 6 ft. 6  $\frac{3}{4}$  in.), was placed under the head of a screwspike; the men then jerked the other end in order to draw the screwspike.

The force required with a screwspike and bush is more than double; moreover, there is this advantage, that even after the screwspike has been drawn several times it can be tightened up again effectively, whereas if the screwspike is by itself, it cannot be used again as the female thread in the wood is destroyed.

## Results obtained at the Paris-Lyons-Mediterranean workshops.

Force applied at the ends of a two-handed box spanner with handles 60 centimetres (2 feet) long.	Pressure obtained (1).	Force required for drawing the spike.
<i>New oak.</i>		
Screwspike with medium pattern bush . . . { 90 kilograms (198 lb.).	5,720 kilograms (12,610 lb.).	1 <sup>st</sup> application . . . { 7,700 kilog. (16,976 lb.). 2 <sup>nd</sup> tightening . . . { 6,500 kilog. (14,330 lb.). 2 <sup>nd</sup> tightening . . . { 5,200 kilog. (11,464 lb.).
Screwspike by itself . . . . . { 90 kilograms (198 lb.).	3,800 kilograms (8,378 lb.).	1 <sup>st</sup> application . . . { 5,200 kilog. (11,464 lb.). 2 <sup>nd</sup> tightening . . . { 3,500 kilog. (7,716 lb.).
<i>Old fir wood in good condition.</i>		
Screwspike with medium pattern bush, of 8 by 4 millimetre ( $\frac{5}{16}$ by $\frac{1}{8}$ inch) wire. . . { 75 kilograms (165 lb.).	5,040 kilograms (11,111 lb.).	1 <sup>st</sup> application . . . { 3,800 kilog. (8,378 lb.).
Screwspike by itself . . . . . { 50 kilog. (110 lb.). (is over-turned).	2,100 kilograms (4,630 lb.).	1 <sup>st</sup> application . . . { 1,800 kilog. (3,968 lb.).
Repair of a hole in fir wood in very good condition by means of large pattern bush . . { 75 kilograms (165 lb.).	4,824 kilograms (10,635 lb.).	1 <sup>st</sup> application . . . { 2,100 kilog. (4,630 lb.).

(1) The core of the screwspike, which only has a diameter of 14 millimetres ( $\frac{11}{16}$  inch), becomes stretched near the neck when the compression is 4,500 kilograms (9,920 lb.).

The table given above shows that when a bush is used to repair a damaged hole, greater strength is obtained than when a screwspike is used in new wood, and that this strength is greater, even when soft wood is used, than the track requires.

The considerable increase in the strength of the fastening resulting from this system, and its special advantages, are shown by the results obtained in particularly bad cases. As instances, we may mention very sharp curves (Paris Metropolitan), iron bridges, longitudinal sleepers, etc.

Although every country is under different conditions, on account of customs, climate and the materials already in use, this system has found applications, everywhere, because of its simplicity and its inexpensiveness, which make it possible to adapt it to all requirements.

In countries where screwspikes are used, the ways in which these bushes can be used are given later on in the list of its principal applications.

In countries where treenails or dogspikes are still used, this system makes it possible to replace them by screwspikes without making fresh holes in the sleepers; and thus a good fastening can be substituted for a defective one.

In the United States of America, where labour is very expensive, and where consequently any method saving labour is much appreciated, the bushes are driven into the sleepers before these are laid. All the man has to do is to drive in the screw, and there is no risk of anything going wrong; this is easier than putting in a dogspike which is generally in an inconvenient position.

The facility with which screwspikes can be put in and taken out when bushes are used, has been utilized more especially in countries where there is a severe climate, such as Canada, Russia, etc.

The inventor lays much stress on the economical results of his system. The saving which the use of the Thiollier bush will effect is as apparent on very busy lines as on lines with less traffic. To give but one instance of this, it would be possible to reduce a gang of platelayers, from five men to three men, as each gang has to look after 6 kilometres (3·7 miles) of line. The saving in the cost of maintenance would be 500 francs per kilometre (£32·4s. per mile) per year. Finally, bushes would make it possible to use softer and cheaper woods with as much safety as harder woods.

#### PRINCIPAL APPLICATIONS OF BUSHES FOR SCREWSPIKES IN RAILWAY WORK.

*Applied away from track.* — Bushes can be used :

- 1° To strengthen a fastening;
- 2° To utilize very soft wood;
- 3° To facilitate driving screwspikes into very hard wood;
- 4° To repair and true holes which are too large or in which the screwspikes no longer hold; even if there is a crack;
- 5° To utilize old screwspikes with worn threads, which otherwise would have to be scrapped.

The bushes can easily be put in by machine at slight expense.

As the bush can be and should be dipped in tar, it is protected against such substances as copper sulphate and zinc compounds with which some sleepers are pickled, and also against becoming rusted by the effect of damp. Thick mineral oils can also be used for this purpose

*Applied on track.* (In case of a screwspike which has stripped its thread.) — In tracks where chairs or bedplates are used, all that is necessary is to slide the support sideways so as to make the hole accessible for tapping. The holes are far enough from the bottom of the rail to give the necessary clearance for working the tap and screwing in the bushes, which only requires 5 or 6 millimetres ( $\frac{3}{16}$  or  $\frac{1}{4}$  inch) more space than the thread of the screwspike.

On a Vignoles track the tap can be put in by inclining or raising the foot of the rail 2 to 4 centimetres ( $\frac{25}{32}$  to  $1\frac{9}{16}$  inch). In this way displacing the sleeper by 3 to 6 millimetres ( $\frac{1}{8}$  to  $\frac{1}{4}$  inch) is avoided, for this operation might disturb the seat of the sleeper on the ballast.

We lay special stress on carrying out the tapping operations under the easiest conditions; time is gained, and trouble and risk of bad fitting are avoided.

**Succession of operations when linings on the J. Thiollier system are put in.**

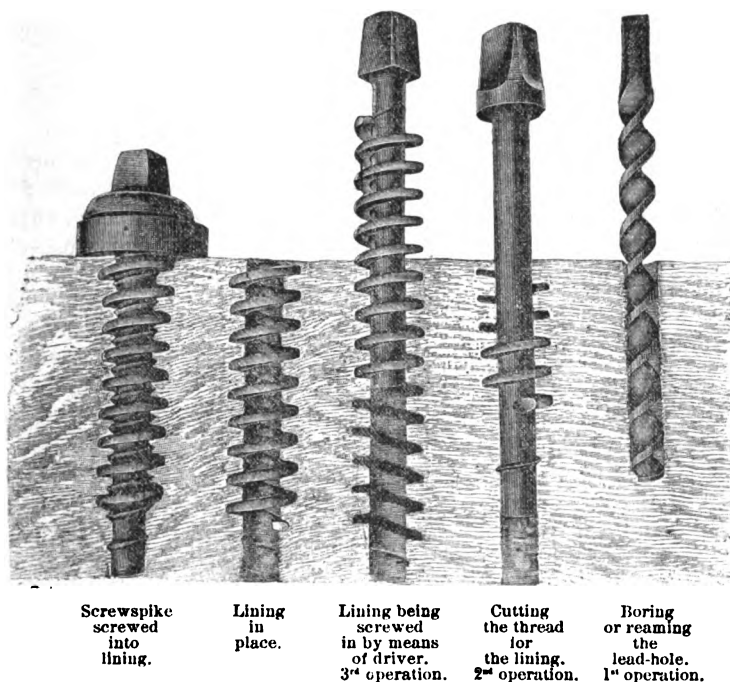


Fig. 7.

*To correct widening of the gauge.* — Whatever be the type of track, all that is necessary is to take out the screwspikes and then move the given length of rail back to its correct position by means of pinchbars, to fix it provisionally in this position by means of a stop (spike or tie-bar); and then to re-bore or clean out the holes which are then threaded to receive the bush. The success of the succeeding operations depends on whether this boring or cleaning is done properly; the plug end which acts as the guide of the tap fitting the walls of the hole exactly and the screwspike coming exactly into the centre of the bush which rests in the thread cut.

The holes in the chairs or bedplates (in the case of tracks where such are used) serve as guides in determining the centres; in the case of a Vignoles track the same method is adopted as when holes are cleaned and plugged.

*An oval hole* can be made good by means of the bush. The latter will enter the wood a little less at the ends of the oval, but will be sufficiently supported by taking against the walls. The screwspike will once more be placed centrally and properly held.

*In a crack.* — As in the case of an oval hole, the bush is sufficiently supported by taking against the walls of the hole. As it acts by compressing the fibre of the wood, it does not tend to open the crack.

*Use of old screwspikes.* — Old screwspikes with very worn threads can be used again, as the bush fits against what is left of the thread and holds against the core.

In the case of screwspikes, coarse threads are the best and give the greatest strength.

In soft wood, bushes made of thick wire are to be preferred.

In order to avoid loss of metal and unnecessary labour care must be taken to select these of a length suited to the thickness of the sleepers in question.

*Use of bushes in masonry work.* — An excellent fastening, which can easily be undone, is made by building into the masonry a screwspike well oiled and screwed right into a bush, the last 4 or 5 turns of which have also been well oiled in order to prevent the adhesion of the cement and to give a little elasticity to the fastening. Once the cement has set, the screwspike can be screwed out or in as may be desired.

---

# THE WESTINGHOUSE ELECTROMAGNETIC BRAKE,

By chief engineer RUDOLF BRAUN.

---

Figs. 1 to 25, pp. 1205 to 1216.

---

(*Elektrische Bahnen und Betriebe.*)

---

Electromagnetic brakes have been of late the subject of more attention than formerly. Their first use on electric railways, in Germany, is due principally to Schiemann. In other countries, particularly in England, they are used very extensively; and in the latter country, they are rapidly replacing the other mechanically operated brakes, as it has been found that they are the only safe brakes in the long run and under very varying conditions, such as occur in big towns where there is heavy traffic and where the condition of the rails is often unsatisfactory. The organization of motor bus services in London, has led to many investigations in order to work out the best brake, so as to render an electric car as safe for the public as a motor bus.

The latter has the great advantage that it can be steered through traffic and so avoid collisions. The safety of a motor bus is, moreover, increased by the very short distance in which it can be pulled up by means of its brakes. Trials have shown that to stop within 2·5 metres (8 ft. 2 in.), when going at a speed of 12 kilometres (7·5 miles) per hour, is nothing extraordinary. That the brakes of a motor bus are as a rule more effective than those of an electric car, is chiefly due to the greater coefficient of friction between the bus wheels and the rough surface of the road. It is true that this superiority of the motor bus is less marked in towns where the adhesion is less or even dangerously reduced if the streets are watered when the mud has not been removed; this disadvantage however also affects all other vehicles.

But these abnormal conditions which exist, for instance, in Berlin, become eliminated of themselves in course of time. The results of the extensive trials made in London have shown very clearly the practical value of the electromagnetic brake. These trials were made principally with two types of brakes :

The first is the purely electromagnetic slipper brake, of the type designed by Schiemann, with the addition of a cranked lever, with its two arms so proportioned that the attraction between the electromagnet and the rail produces a greater pressure. This greater pressure reduces the wheel-loads to a corresponding extent; but the wheels do not become locked as long as the braking moment produced by the motors generating the current operating the electromagnets is less than the maximum braking effect of the wheels, *i. e.* the wheel-load multiplied by the coefficient of friction.

This brake certainly works very well; moreover, it is very simple and consequently few repairs are necessary, unless something goes wrong with the electrical gear. But it does not fully utilize the adhesive weight of the cars, or if it does so, the braking of the axles is only effected by the motors, which consequently are liable to become overheated.

In order to avoid this disadvantage, the electromagnets of the Westinghouse electromagnetic brake are mechanically connected with the gear operating the brake blocks, so that the magnetic attraction is also utilized for applying the brake blocks to the wheels. This arrangement makes it possible to utilize to the fullest extent all possibilities of stopping the vehicle.

The axles, whether braked mechanically by brake blocks applied to the wheels, or electrically by the motors acting as generators, can be braked to the extent of 90 per cent of the maximum force of adhesion between wheel and rail. The ratio of magnetic attraction to brake block pressure adopted is such that this limit cannot be exceeded. It is regulated automatically, for if the track is greasy, the magnetic attraction is less, so that although the adhesion between wheels and rails is reduced, there is no chance of locking the wheels; and if the wheels became locked the retardation would of course be reduced. Moreover the electromagnet, when sliding on the rails, tends to reduce their greasiness.

We give figures of several types of Westinghouse brakes.

Figure 1 is the early type, as first proposed by Newell; it has inside brake blocks.

Figure 2 shows the Mark Cummins pattern. The brake gear is much simpler than in the preceding type.

These two types can however only be used if the wheel-base is short, as the rods work in compression.

With a longer wheel-base, an arrangement similar to that shown in figure 3 should be used. In this the rods work in tension. The brake blocks are on the outer side of the wheels. However, blocks may be both outside and inside. Figure 4 shows a pattern fitted to a bogie with unequal wheels, figure 5 to one with equal wheels.

Many other types are also used, particularly for cars taking current from a conduit, as for instance in London and in Bournemouth. This brake has also been used with success on cars with radial axles (fig 6). It may be stated generally, that suitable brake gear of this kind can be designed for any car. The figures show several patterns used in actual practice; they are of interest as showing applications to very different underframes.

Trailer cars are fitted just like the motor cars, and the electromagnets are coupled up in parallel to one brake main.

The electromagnets themselves were originally of the shape shown in figures 1 to 5. This has, however, now been replaced by a new shape (patented by the author) which makes it possible to obtain very great power with a comparatively small amount of metal.

The curves showing the attraction of the magnets may be used with advantage. The magnets shown in figures 1 to 5 give the curve shown in figure 7.

With the older patterns of electromagnets used, the amount of attraction depended on the cross-section of the rail. It is not possible to do more than saturate the cross-section. In order to overcome this objection, a number of poles are used, in some designs; but this has the following disadvantages:

- 1° The electromagnet must be very long if it is to be sufficiently powerful for practical use;
- 2° The spaces between the poles are wasted as far as attraction is concerned. They are also objectionable, from the mechanical point of view, at crossings, if these are not in very good condition, as any projecting parts of the rails easily catch in these spaces;

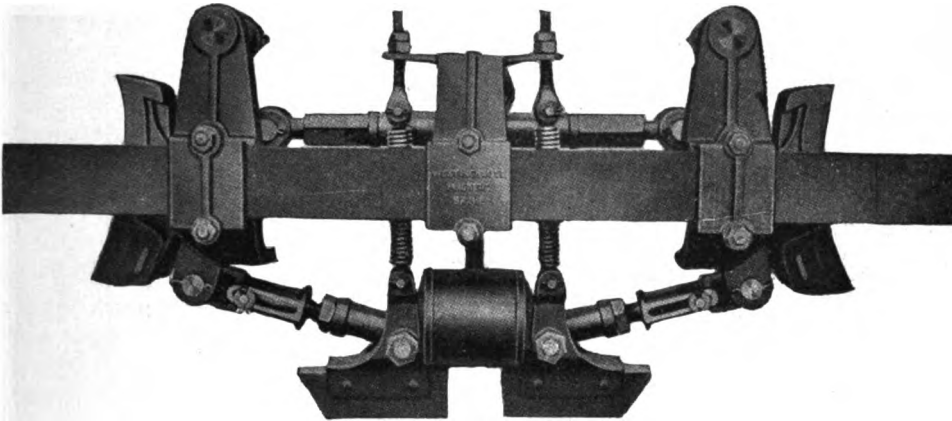


Fig. 1. — Westinghouse electromagnetic brake, original pattern.

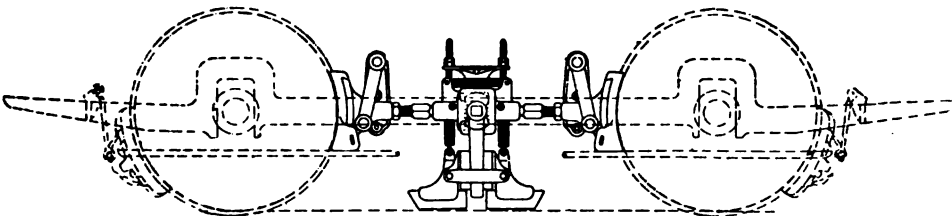


Fig. 2. — Westinghouse electromagnetic brake, the Mark Cummins pattern.

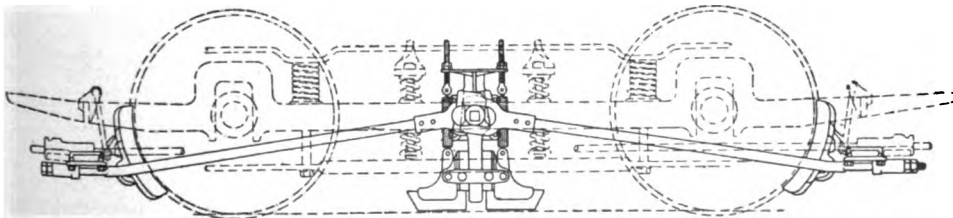
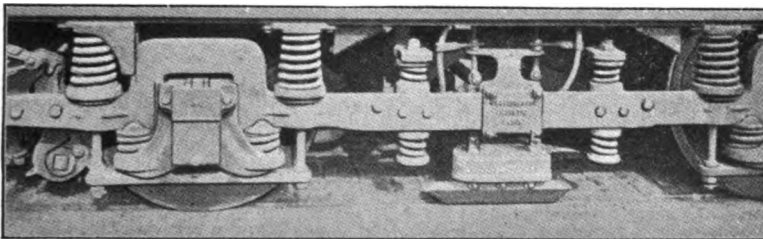


Fig. 3. — Westinghouse electromagnetic brake, long wheel-base.

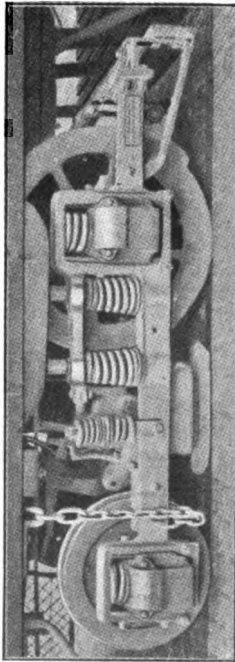


Fig. 6. — Westinghouse electromagnetic brake, radial axes with brake-blocks on both sides.

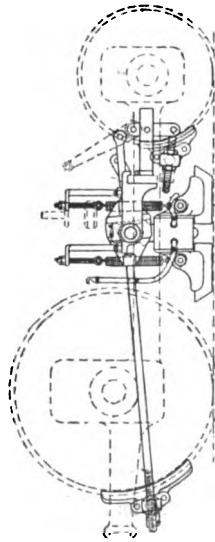


Fig. 4. — Westinghouse electromagnetic brake, maximum traction bogie.

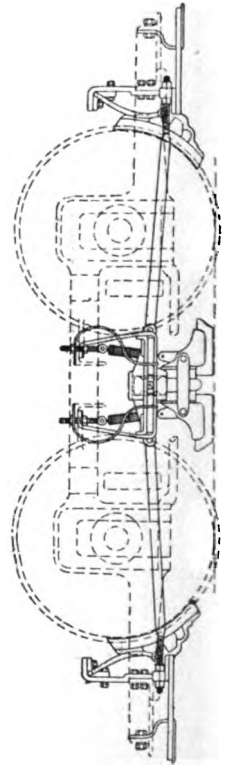
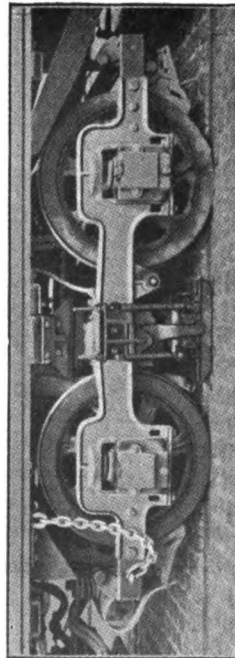


Fig. 5. — Westinghouse electromagnetic brake, ordinary bogie.

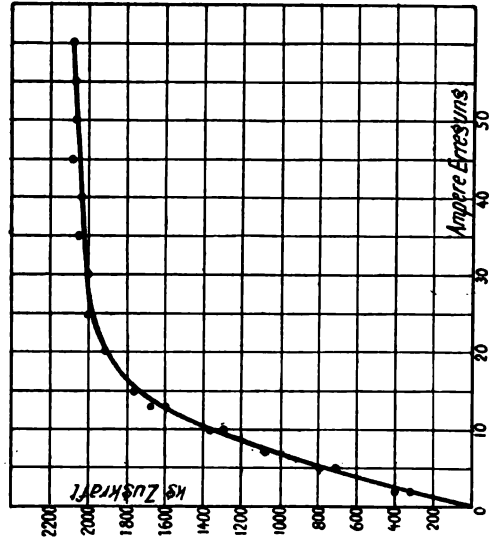


Fig. 7. — Westinghouse electromagnetic brake. Curve showing attraction.

Explanation of German terms : Amperes Erregung = Excitation in amperes.  
Kg Zugkraft = Attraction in kilograms.

3° The renewal of the slipper blocks is more costly than in the type which will be considered later on;

4° It is difficult to maintain, in practice, the insulation of the many coils and connections; wet soon exercises a very disastrous effect if there are even slight faults;

5° The resistance, in ohms, of the numerous coils is so large that at low speeds, *e. g.* 1 kilometre (0·62 mile) per hour, it is impossible to apply the brakes suddenly.

These difficulties are overcome in a very simple manner in the electromagnet designed by the author, by having transverse instead of longitudinal magnetization in the rails. The following advantages result :

1° The electromagnet has only two surfaces in the direction of the rails;

2° The empty spaces over the rails are eliminated. The electromagnet cannot catch at crossings. The whole rail is utilized for the brake action. The length of the electromagnet is much reduced. For instance, with a total length of 42 centimetres (1 ft. 4 <sup>9</sup>/<sub>16</sub> in.) on the rail, the electromagnet has the curve figure 7, which is very similar to the one previously obtained with a 9 pole electromagnet about twice as long;

3° The two slipper blocks consist of flat bar; their renewal is consequently a very inexpensive matter;

4° There is only one coil, wholly encased in steel (*see* figs. 3 to 6). The joints are brazed and soldered. It is easy to insulate the coil properly and permanently;

5° The resistance of the one coil, which is made of thick strip, is only a small fraction of an ohm; it is hence practically negligible.

Consequently, this brake acts as readily at low speeds as the rheostat brake. This point is of great importance in towns with much traffic, where cars having their speed already much reduced, have often to stop suddenly at points where roads cross. An electromagnetic brake which only works at higher speeds, *e. g.* at over 3 or 4 kilometres (1·86 or 2·5 miles) per hour, should not be used in towns.

The information so far published about electromagnetic brakes, is chiefly of a theoretical nature. In order to determine the value of these brakes in actual practice, extensive trials were made on the lines of the London County Council, under the author's supervision. The object of these trials was to determine the following points :

1° Within what distances can stops be effected, when running at certain maximum speeds, on dry rails and on greasy rails, in cases of ordinary stops and of emergency stops :

a) By means of the rheostat brake?

b) By means of the electromagnetic brake?

2° What is the action, at any given moment and also over the whole period, of each of the separate parts concerned in the braking : motors, rheostats, slipper blocks and brake blocks?

3° What currents are produced by the motors during the operation, and of what voltages?

4° What are the mean and the maximum values of the currents and the voltages?

5° How much heat is produced in the electric circuit, and what percentage of the total kinetic energy of the car is transformed into heat by the motors?

6° How do the brakes work at very low speeds?

7° How does the car behave on falling gradients?

8° Does powerful braking inconvenience passengers? How does it affect them?

9° How are the rails affected? How do the electromagnets and rails wear?

Instruments required for this investigation were kindly lent by the British Thomson-Houston Company, and they were looked after by one of the engineers of that company. Among them were :

- 1° A recording ammeter;
- 2° A recording voltmeter;
- 3° A recording speed gauge.

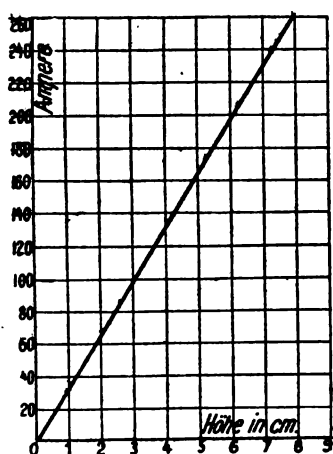


Fig. 8.

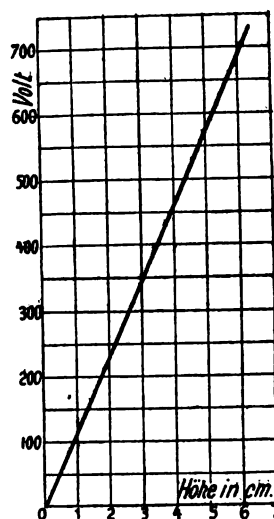


Fig. 9.

Figs. 8 and 9. — Calibration curves of ammeters and voltmeters used in Westinghouse brake trials.

*Explanation of German terms :* Ampere = Amperes. — Höhe in cm. = Height in centimetres; — Volt = Volts.

The ammeter and voltmeter were very accurate instruments made by the General Electric Company. Their action is based on the dynamometer principle. One of the coils is fixed, the other is movable. The latter is excited by an accumulator battery, and the current can be adjusted by means of a spiral resistance with sliding contact. The exciting current was continually controlled by means of an accurate Weston ammeter, and it was kept at the value shown in the calibration curves of the National Physical Laboratory, which had tested the instruments a short time before the trials commenced, January 31, 1905. The calibration curves are shown in figures 8 and 9. The fixed coil of the instrument is excited in the ammeter by the total braking current, in the voltmeter from the terminals of the motors, which are coupled up in parallel during the braking.

The movable coil has a style fixed to it, which records the movements on a strip of paper driven

by clockwork. The time is recorded, every five seconds, by a small pencil operated by an electromagnet.

In addition, a special contact was placed provisionally on the controller, so that a circuit was made as soon as the handle of the controller was moved into the position for beginning braking. The time pencil also recorded this moment on the paper strip. This enabled the time required for braking to be measured accurately.

The speed gauge used was a Boyer Speed Distance Recorder, made by the Boyer Machine Company, of Detroit, Mich. This apparatus has a small centrifugal oil pump. The pressure acts on a small piston which compresses a spring, and so the movement of the piston measures the speed. It is recorded on a strip of paper which is driven, by means of gearing, by the axle; so the travel of the paper is always proportional to the distance the car has run. The instrument was adjusted so that 29 inches = 736 millimetres of the paper corresponded to a run of 1 mile = 1,609 metres.

The accuracy of this adjustment was checked by a large number of measurements made on a straight and level section of line  $\frac{1}{2}$  mile = 805 metres long; this section had been carefully measured by means of a tape.

The diameter of the belt driven pulley working the instrument could be increased or reduced to a slight extent, and this made it possible to adjust the ratio of reduction of the gearing very accurately. The calibration curve of the speed recorder is shown in figure 10.

The speed gauge was also fitted with an electromagnetic device which marked on the paper the moment the braking began. A second mark was made the moment the car stopped; the handle of the controller was then moved back to the starting position. The length of stop was thus shown by the distance between these two marks on the strip of paper.

This method of procedure eliminated any important errors of observation. The accuracy of all the instruments used was once more checked by the engineers of the London County Council and of the various firms concerned, before the trials began.

The observations were carried out during a series of trial runs made between evening and morning during six nights, within a period of three weeks. Sand was not used during the trials. Many trials were made, the brakes being used about 500 times, and the results were plotted as curves.

The car used for the trials weighed nearly 12 tons, instruments and observers included. The body was carried on two bogies of the type shown in figure 4. Each bogie had two electromagnets joined in series. The two bogies were coupled up in parallel, so that the total resistance of the four electromagnets was the same as that of a single one.

Each bogie had a Westinghouse motor No. 200M, of 30 horse-power. Figures 11 and 13 give the particulars. These motors are joined in parallel while the braking is effected. The controller had seven contacts for brake applications.

The particulars of the braking, with a mean of 25 amperes (maximum, about 30, and minimum, about 20 amperes) are shown in the Müller braking diagram, figure 16. Figure 12 shows some of the amperage, voltage and speed curves recorded by the instruments.

Characteristic instances of emergency stops are shown in figures 14 (rheostat brake) and figures 15 (electromagnetic brake). In both cases the maximum speed was the same, and the diagrams are on the same scale. In the trial of figure 14 the electromagnets had been short-circuited. The trial with the rheostat brake shows the well-known jerky action. The current varies considerably; the average amperage remains nearly the same at all speeds. There are many more maximums than brake contacts on the controller; this is due to the fact that when

an emergency stop is made with the rheostat brake, and no sand is used, it is very difficult to avoid locking the wheels at times. Of course this was prevented as much as possible, so as to reduce the length of stop. The amperage (fig. 15) falls progressively from the maximum to

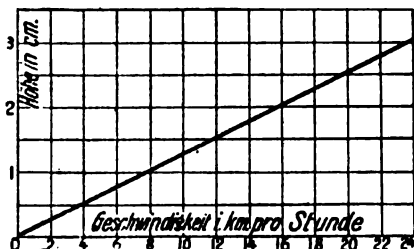


Fig. 10. — Calibration curve of speed gauge.

*Explanation of German terms of the figure 10 :* Geschwindigkeit i. km. pro Stunde = Speed in kilometres per hour. — Höhe in cm = Height in centimetres.

*Explanation of German terms of the figure 11 :* Abgegebene Leistung = Power given. — Drehzahl bei 75° C. = Number of revolutions at 75° C. — Geschwindigkeit bei 525 volt = Speed at 525 volts. — Wirkungsgrad = Efficiency. — Zugeführte Leistung = Power absorbed. — Zugkraft = Pull.

*Ordinates.* — 1<sup>st</sup> col. : number of revolutions and kilograms; 2<sup>nd</sup> col. : percentages and horse-power; 3<sup>rd</sup> col. : kilometres per hour.

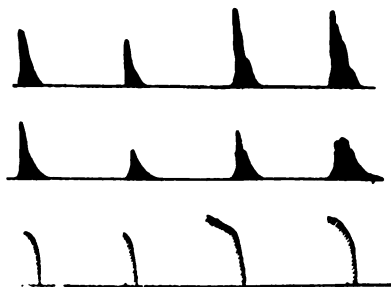


Fig. 12. — Specimens of amperage, voltage and speed curves recorded during the trials.

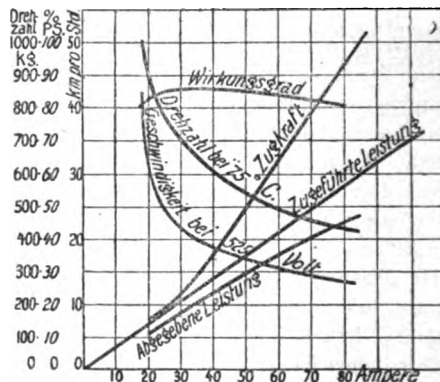


Fig. 11. — Particulars of Westinghouse motor No. 200 M, of 30 horse-power.

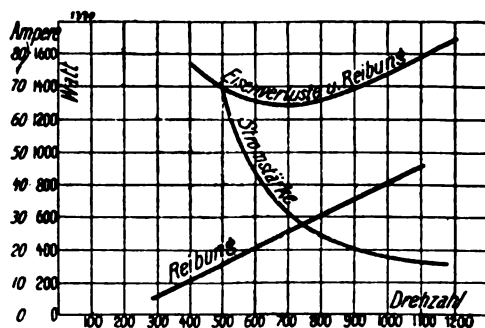


Fig. 13. — Losses of Westinghouse motor No. 200 M, of 30 horse-power.

*Explanation of German terms :* Drehzahl = Number of revolutions.

Eisenverluste u. Reibung = Losses in iron and friction. — Reibung = Friction. — Stromstärke = Intensity.

zero, and becomes reduced as the speed becomes reduced. This property, which results from the construction of the Westinghouse brake, is very important as regards the efficiency of the brake, for as the coefficient of friction between the brake blocks and the wheels is smaller at higher speeds, it is necessary for the brake block pressure to be reduced automatically as the speed becomes reduced, or else the wheels will become locked. The electromagnet (figs. 3 to 6)

is constructed so that its core does not become saturated within the limits of the use of the brakes in actual practice (fig. 7), and so that the change in the coefficient of friction is compensated by suitable adaptation of the magnetization curve of the steel. Consequently, in spite of the reduction of the brake pressure, the brake action is not reduced; nor is it exceeded.

If the amperage and voltage curves are examined, it will be noticed that the current sometimes continues to flow after the car has stopped, often even for two seconds (figure 15 shows half a second). It was found that this phenomenon was not due to the inertia of the mass of the movable coil, as the style, if moved by hand, at once returned to the zero line, without marking any such curve on the paper.

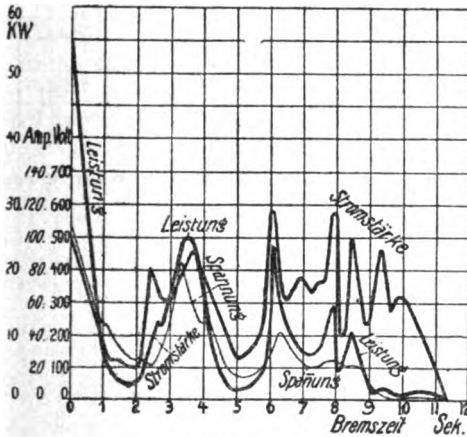


Fig. 14.

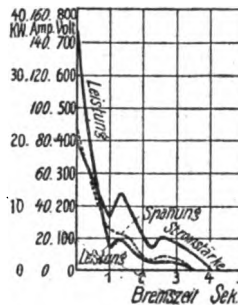


Fig. 15.

Figs. 14 and 15. — Emergency stops, rheostat brake and Westinghouse brake.

Explanation of German terms : Bremszeit Sek. = Time of braking in seconds. — Leistung = Power.  
Spannung = Pressure. — Stromstärke = Intensity.

It was recognized that the true cause of this phenomenon was the self-induction of the motors and of the electromagnets. If the instrument was short-circuited at the moment of stopping, the curve disappeared. This property is by no means a disadvantage; it contributes essentially to the fact that the car is quite stopped, even on steep falling gradients, by the use of the electromagnetic brake alone, and then remains standing still for the next three to five seconds, after which it slowly moves down about 50 centimetres (1 ft. 7  $\frac{11}{16}$  in.), and then stops again. This property is characteristic of the Westinghouse electromagnetic brake and is very valuable in actual practice.

By multiplying together the ampere and voltage values obtained simultaneously during all the trials, the watt curves shown in figures 14 and 15 were obtained.

The surfaces bounded by the ampere curves represent the ampere-seconds, that is to say, the total quantity of electricity which has passed through the circuit during the braking operation. The surfaces bounded by the watt curves represent the total number of watt-seconds developed during the braking operation, that is to say, the heat produced within the brake circuit.

Figure 17 shows the result, in ampere-seconds, for the rheostat brake and the electromagnetic

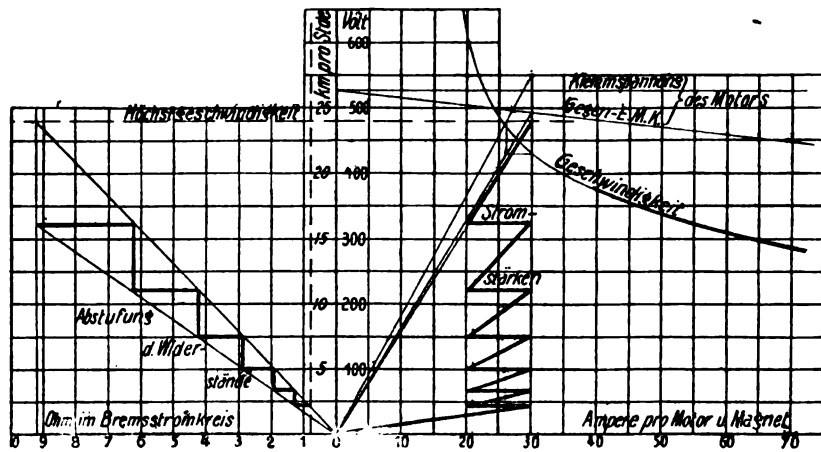


Fig. 16. — Müller brake diagram. Westinghouse motor No. 200 M of 30 horse-power.

Explanation of German terms: Abstufung der Widerstände = Graduation of resistances. — Ampere pro Motor u. Magnet = Amperes per motor and per electromagnet. — Höchstgeschwindigkeit = Maximum speed. — Klemmspannung des Motors = Pressure at terminals of motor. — Gegen-E. M. K. des Motors = Counter-electromotive force of motor. — Ohm im Bremsstromkreis = Brake circuit, number of ohms. — Stromstärken = Intensities.

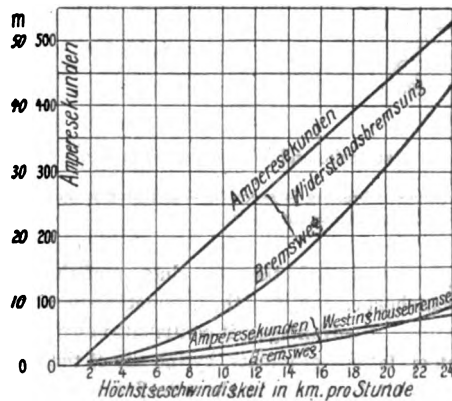


Fig. 17. — Braking power and length of stop, rheostat brake and Westinghouse brake.

Explanation of German terms of the figure 17: Amperesekunden = Ampere-seconds. — Bremsweg = Length of stop. — Widerstandsbremse = Rheostat brake.

Explanation of German terms of the figure 18: Bremsweg in m. = Length of stop in metres. — Höchstgeschwindigkeit in km. pro Stunde = Maximum speed in kilometres per hour.

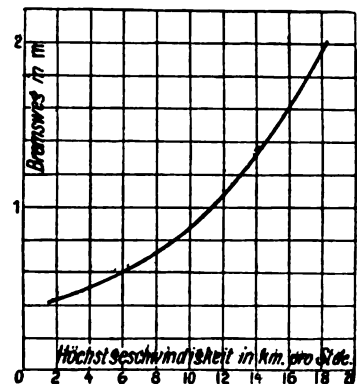


Fig. 18. — Minimum length of stop, on dry track.

brake, referred to the maximum speed at the moment the brakes are applied. Ordinary stops and emergency stops gave nearly straight lines. This result can also be explained theoretically if we assume that for equal speeds the action of the brakes on the car increases and decreases

with the strength of the current. For the same maximum speed, the more current there is, the greater the deceleration and the shorter the time required for stopping; or, expressed mathematically, let :

$v$  = maximum speed ;  
 $\gamma$  = deceleration ;  
 $t$  = time of stopping ;  
 $i$  = strength of current ;  
 $K$  = constant ;

so that

$$\gamma = K \cdot i,$$

then :

$$v = \gamma \cdot t = K (it).$$

In other words, the quantity of current only depends on the speed, not on whether the brakes are applied more or less strongly; if the speed is twice as great, twice as much electricity will be required.

Figure 17 shows the average length of stop in the case of emergency stops on a wet track, considered slippery by the experts, as being in the greasy condition which results in London at that time of year (February) owing to the damp air and the dirt produced during the day.

Figure 18 shows the results of braking trials carried out inside a large covered shed on an absolutely dry and good track.

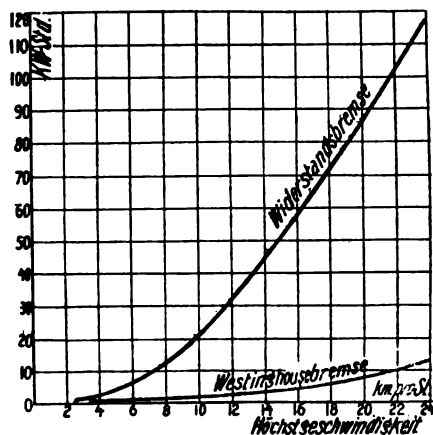


Fig. 19. — Power developed in brake circuit.

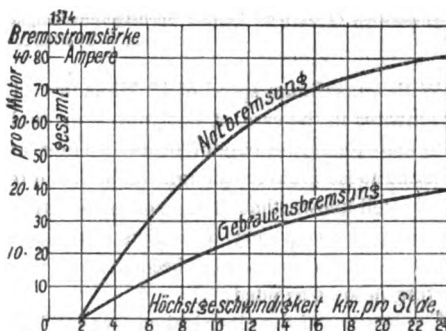


Fig. 20. — Maximum intensities, Westinghouse brake.

Explanation of German terms of the figure 19 : Höchstgeschwindigkeit km. pro St. = Maximum speed in kilometres per hour. — Kw-Std. = Kilowatt-hour. — Widerstandsbremse = Rheostat brake.

Explanation of German terms of the figure 20 : Bremsstromstärke pro Motor = Brake circuit intensity per motor. — Bremsstromstärke gesamt = Total brake circuit intensity. — Gebrauchsbremsung = Ordinary stops. — Notbremsung = Emergency stop.

Figure 20 gives the momentary maximum strength of the current in stops made by means of the Westinghouse brake, as shown in all the curves recorded. These maximums are to be

understood as occurring at some moment during the braking, not as occurring exactly at the maximum speed. With the rheostat brake, these figures for the strength are 100 to 120 per cent greater. As for the voltages, the maximums were, for instance, 225 volts with the Westinghouse brake and 375 volts with the rheostat brake, at 16 kilometres (9.9 miles) per hour, and 450 and 700 volts respectively at 24 kilometres (14.9 miles) per hour.

Figures 21 and 22 give the mean values for the amperage and the voltage.

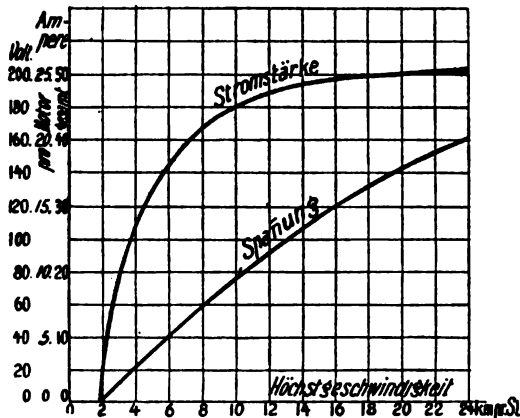


Fig. 21.

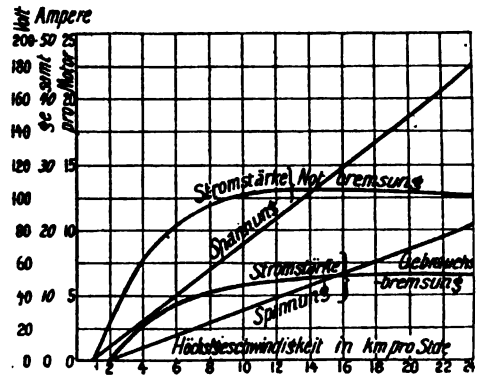


Fig. 22.

Figs. 21 and 22. — Mean intensity and pressure, rheostat brake and Westinghouse brake.

Explanation of German terms : Höchstgeschwindigkeit km. pro St. = Maximum speed in kilometres per hour.  
Spannung = Pressure. — Stromstärke = Intensity.

With a maximum speed of 19 kilometres (11.8 miles) per hour, the mean intensity was about 50 amperes in the case of ordinary stops and emergency stops with the rheostat brake; and 13.5 amperes in the case of ordinary stops and 26 amperes in that of urgency stops, with the Westinghouse brake, although the brakes often acted more powerfully. (See below.)

It is well known that the rise of temperature produced by repeated applications of the rheostat brake often has a very disastrous effect on the electrical equipment of cars. As a rule, the motors and resistances often become heated quite enough during their regular work, and further heating is to be avoided.

The heating of the electrical equipment depends, in the first place, on the amount of heat generated, and this depends on the number of kilowatt-seconds produced during the braking and transformed into heat in the circuit. In order to compare the kilowatt-seconds produced with the rheostat brake and with the Westinghouse brake, we show them in figure 19 as functions of the maximum speed. It will be seen that the electromagnetic brake gives but little, and consequently only an insignificant rise of temperature is produced during the braking. An example will make this clear. If at a speed of 19 kilometres (11.8 miles) per hour, the equipment of a braked car shows an increase of temperature of 30° C. (54° Fahr.) with the rheostat brake, then assuming that the rise of temperature of the same equipment, but with the electromagnetic brake, is proportional to the kilowatt-seconds produced, this ratio will be as 7 to 81 kilowatt-seconds, i. e. as 1 to 11.5.

The rise of temperature can thus, under such conditions, only amount to  $\frac{30}{11.5} = 2.6^{\circ}$  C. ( $4.7^{\circ}$  Fahr.) with the electromagnetic brake, and is hence negligible; whereas a rise of  $30^{\circ}$  C. ( $54^{\circ}$  Fahr.) may occasionally have disastrous result when the motors in ordinary running already become heated  $70$  or  $80^{\circ}$  C. ( $158$  or  $176^{\circ}$  Fahr.).

The two curves in figure 19 show the electrical energy in each case.

Figure 23 gives a summary of the results in another way. The decelerations in kilometres per hour are given as a function of the maximum speeds at which the brakes were applied.

The decelerations obtained by the rheostat brake never, in the case of emergency stops, exceed 2 kilometres ( $1.24$  mile) per hour per second, although everything (sand excluded) was done to obtain the best possible result. Under the same conditions and on the same track, the Westinghouse electro-magnetic brake gave  $9.5$  kilometres ( $5.90$  miles) per hour per second, and this was practically constant at speeds over about 10 kilometres ( $6.2$  miles) per hour. The decelerations shown in figure 23 are the means during the whole time of braking. They are calculated from the maximum speeds and the lengths of stop (fig. 18) by means of the equation  $\frac{v^2}{2gs}$ .

The time which elapses until the motors are fully excited does not exceed  $\frac{1}{4}$  second and is materially shorter than the time required for applying the hand brake or the compressed air brake : that is the advantage of using electricity.

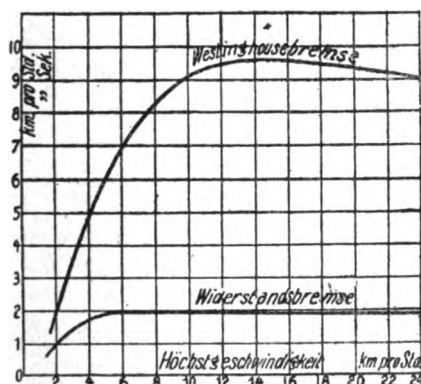


Fig. 23. — Mean decelerations.

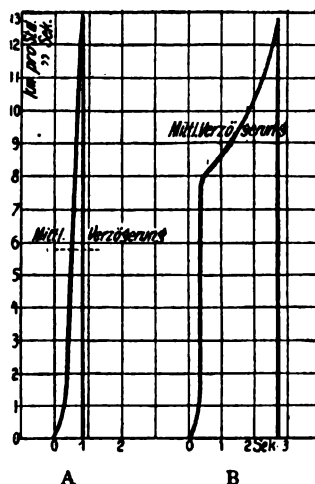


Fig. 24. — Two examples showing how the braking proceeds, Westinghouse brake.

*Explanation of German terms :* Höchstgeschwindigkeit km pro Std. = Maximum speed in kilometres per hour. Km. pro Std. pro Sek. = Kilometres per hour per second. — Mittl. Verzögerung = Mean deceleration.

Two deceleration curves showing the action of the Westinghouse brake are given in figure 24, one at moderate speed and one at high speed (curves A and B). In case A, the curve ascends to a maximum which is reached at the moment of stopping. At higher speeds, the curve ascends a little more quickly than in curve A, but stops at an intermediate value. Then, the speed

becoming reduced, the same maximum is attained in case B as in case A. It will be seen that in case A, the mean is less than in case B, although in case A the maximum deceleration is attained in less time; for these reasons the curves at first sight seem rather paradoxical (fig. 23).

If we consider the whole trials and strike a balance, in other words if we investigate how, and in what proportions, the kinetic energy is transformed during the braking, we arrive at a very interesting result. We will take the results obtained at the speeds of 16 to 24 kilometres (9·9 to 14·9 miles) per hour and we will assume that the total kinetic energy of the car is represented by 100, so that the different items are percentages.

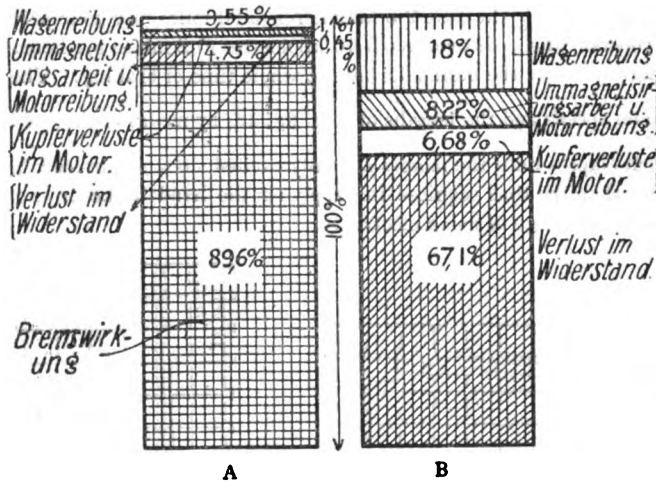


Fig. 25. — Comparison of losses, Westinghouse brake (A) and rheostat (B).

*Explanation of German terms:* Bremswirkung = Action of brakes. — Kupferverluste im Motor = Losses in copper of motor. — Ummagnetisierungsarbeit u. Motorreibung = Transformation in electromagnets and friction. — Verlust im Widerstand = Loss in the resistances. — Wagenreibung = Friction of car.

Figure 25 shows this summary for the Westinghouse brake (A) and for the rheostat brake (B). The resistance of the car (the rolling resistance plus air resistance) is 3·55 per cent in case A and 18 per cent in case B. This difference is due to the fact that the length of stop is greater in the second case. The loss in the iron and the friction of the motors amount to 1·64 per cent of the total kinetic energy of the car in case A, and to 8·22 per cent in case B. The loss in the copper of the motors is 0·45 per cent in case A, and 6·68 per cent in case B; that in the resistances is 4·75 per cent in case A, and 67·1 per cent in case B. All these different factors come into play during the braking, and add up to 100 per cent, the total kinetic energy of the car.

It may be advisable to explain how these figures are arrived at. The resistance of the car was determined, on the one hand, by calculation according to the accepted formulæ, and directly by starting the car and then measuring the time and distance within which it stopped. We know that the tangent of this curve is proportional to the resistance to friction. The loss in the iron and the friction in the motors were determined in trials made at the works where they were manufactured (fig. 13), and the values for the speeds and currents in question were taken from

these records. These values of course vary a little with different motors; but the difference cannot be great, and the ratio for the two brakes can change even less.

The loss in the copper was calculated from the square of the momentary intensities of the recording instrument and the resistance of the motors when running. The curves  $i^2w$  measured with a planimeter then give the total loss.

The loss in the resistances was determined by multiplying the momentary values of the amperage and voltage, and measuring the watt curves with a planimeter. By adding up these different values, the total kinetic energy of the car  $\frac{mv^2}{2}$  (momentum of the revolving wheels and armatures included) was obtained with great accuracy.

By adding up the same values in case A, we only obtain 10.4 per cent, so that the balance, 89.6 per cent, must have been destroyed by the Westinghouse electromagnetic brake, that is to say, by the friction between slippers and rails and between brake blocks and wheels.

In order to check the accuracy of this figure, the magnetic attraction of the slipper brakes to the rails was measured directly at different speeds, and the results obtained were checked by the attraction curves. By taking into consideration the mechanical ratio of the brake gear and the coefficient of friction of the brake blocks, it was possible to calculate the total forces. Moreover trials were made, the car being started and then allowed to come to rest, with the electromagnets excited by a battery of accumulators, and that with :

- 1° The slipper brake only ;
- 2° The slipper brake and the brake blocks acting on the wheels.

The retardation so determined agreed very well with the 89.6 per cent as given above.

Comparing the ratio of the similar losses of the rheostat brake and of the electromagnetic brake, the following figures are obtained :

Loss due to resistance of car . . . . .	18.0 : 3.55 = 5.08 : 1.
— in the iron and friction in the motors . . . . .	8.22 : 1.64 = 5.01 : 1.
— in the copper of the motors . . . . .	6.68 : 0.45 = 14.85 : 1.
— in the rheostats. . . . .	67.1 : 4.75 = 14.1 : 1.

The rise of temperature in the electrical equipment is thus about fourteen times as great with the rheostat brake as with the electromagnetic brake.

The author has often been asked the following question : How is it that with an identical electrical equipment, including similar motors, controllers and resistances, there is much less current, and consequently less heat, when the electromagnetic brake is used ?

The answer to this question is that the motorman, feeling the greater retarding force which is produced, himself sets the handle of the controller, at the same given velocity, on a contact corresponding to a greater resistance than when operating the rheostat brake. When the braking commences, the handle being on contact No. 1, the current, it is clear, is the same. But whereas with the rheostat brake, the motorman perhaps at once goes on to contacts Nos. 2 and 3, because the brake does not seem to him to act strongly enough when contact No. 1 is used, with the electromagnetic brake he continues on contact No. 1 ; and once the change of phase is acting, he can, even more quickly than with the rheostat brake, place the handle in the short circuit position, as the greater deceleration reduces the speed more quickly.

A very interesting fact comes out in these trials. Adding the losses in the motors and the rheostats together, we obtain in the case of the electromagnetic brake  $1.64 + 0.45 + 4.75$

= 6.89 per cent of the total kinetic energy of the car. Now if we consider that the *vis viva* of the armatures is equal to from 5 to 8 per cent, we are led to the conclusion that the latter suffices for producing the energy necessary for the braking. Thus while the brakes are on there cannot, on the whole, be any appreciable pressure between the teeth of the gears concerned.

This fact shows in a clear way that the known disadvantages of the rheostat brake are entirely eliminated in the Westinghouse brake.

Although these tramway trials in London were all carried out without any sand being used, it is nevertheless advisable to use sanding in cases of emergencies, for the increase in the coefficient of friction results in a material increase in the deceleration. But on the other hand, it should be used in such cases only, owing to the increased wear of the rails, wheels and brake blocks. The automatic sanding apparatus consists of electromagnets which open the sand boxes at the controller end as soon as the strength of the current exceeds a certain predetermined limit. It follows that sand does not fall during ordinary stops, but only when in cases of emergency the motorman sets over his handle very quickly.

Does a strong negative acceleration, for instance of 12 kilometres (7.46 miles) per hour per second, inconvenience the passengers? In order to ascertain this, it is necessary to calculate what force is acting on his body. Assuming that a passenger weighs 75 kilograms (165 lb.), the force acting on him will be  $\frac{75}{9.81} \times \frac{12}{3.6} = 25.4$  kilograms (56 lb.) or about one-third of his weight

This force will make him slide along a smooth wooden seat; this was also ascertained experimentally. Such a sudden emergency stop is thus not agreeable. But as a rule, no injuries result. If through some unfortunate concatenation of circumstances such were produced, they could only be slight. If by such an emergency stop the life or limbs of a man on the track can be saved, this more than makes up for the momentary inconvenience of the passengers.

At very low speeds, *e. g.* 1 to 2 kilometres (0.62 to 1.24 mile) per hour, the electromagnetic brake acts with certainty. All that is necessary is to turn the handle to the last contact. In this respect, the Westinghouse electromagnetic brake is remarkably efficient. This property is due to the very low resistance of the coils of the magnet, whereas other electromagnets, particularly those with several coils, have resistances of 1 ohm and upwards. This makes them very inefficient at low speeds, and yet these are constantly occurring in large towns where there is much traffic.

As regards the wear of the rails, it is naturally difficult to make accurate measurements. However experience has shown that the wear of the electromagnets of the Westinghouse brakes in daily use in England (at present there are nearly 2,500 cars so fitted) is such that their life is from six to eighteen months, according as the track is level or undulating <sup>(1)</sup>. The slipper blocks are made of mild steel, so that the wear which occurs over the length of the rails and which is due to the slippers, must be much less. The practical result is that the rails are worn much more quickly if hand brakes or compressed air brakes, and sand are used, than with the Westinghouse electromagnetic brake, which exercises a powerful braking action in spite of the smooth surfaces which are in contact.

The rails should be kept as free from sand as possible.

(1) In England the following number of cars had a Westinghouse electromagnetic brake equipment 14 in 1900; 216 in 1901; 563 in 1902; 1,210 in 1903; 2,035 in 1904.

The trials made lead to the following conclusions :

- a) The Westinghouse electromagnetic brake makes it possible to brake at any speed with whatever power may be required in practice;
  - b) It is superior, in the case of emergency stops, to all other brakes at present known, as regards simplicity of working, shortness of time in which applied, and retarding power;
  - c) It is without the jerky action of the rheostat brake, its uncertain action, and its great development of heat in the motors and rheostats;
  - d) Owing to its simple construction and the small amount of maintenance required, it is cheaper to use than any other tramway brake, whether operated by hand or by compressed air.
-

## FINAL RESULTS OF THE SIMPLON TUNNEL SURVEY,

By Professor Dr. M. ROSENMUND, of Zurich.

(PAPER READ BEFORE THE " ASSOCIATION DES INGÉNIEURS ET ARCHITECTES SUISSES ",  
AT THEIR 41<sup>st</sup> GENERAL MEETING AT ZURICH, JULY 30, 1905.)

Fig. 1, p. 1221.

(*Schweizerische Bauzeitung*.)

In appearing before you to-day, with the intention of describing to you the ultimate results of the Simplon tunnel survey work, I must admit that I am in a position of some difficulty. At the time when, on the invitation of your President, I agreed to bring the matter before you, there was every reason to believe that at Whitsuntide it would be possible to determine to what extent the two axes of the tunnel agreed. But the delay in the completion of the tunnelling interfered with the final verification, and even to-day I could add nothing to what you could have read, shortly after the two ends met, in the *Schweizerische Bauzeitung*, namely that there has been no material divergence in direction or height, but that the length appears to be about 1 to 2 metres (3 ft. 3  $\frac{3}{8}$  in. to 6 ft. 6  $\frac{3}{4}$  in.) less than the triangulation indicated, — were it not that the very natural curiosity of the executive engineers in charge has enabled me to know the results of some preliminary verifications. In spite of the serious difficulty of making any accurate measurements during the short and fleeting moments during which actual work is suspended, these engineers have tried to extend the centre line of the tunnel from the last well-determined bench marks on the south side to the last well-determined bench marks on the north side, and also to determine, by means of levelling, what difference in height a given mark showed according as it was measured from the south entrance or from the north entrance of the tunnel.

It was then found that the lateral divergence of the two centre lines or axes was 5 centimetres (1  $\frac{31}{32}$  inch) and the difference in height was 9 centimetres (3  $\frac{17}{32}$  inches).

As far as I know, the length of the tunnel up to the point where the two ends met has not yet been finally checked.

The direction in which the tunnel was to run, was based on the results of the triangulation work carried out in 1898. The more carefully the angles of the system of triangles are measured, the more probable it is that the centre lines on both sides can be fixed accurately. In order to determine the accuracy of such measurements, the mean probable error is worked out; this may be defined as being of such magnitude, that it is equally probable that the actual error is larger or smaller. Suppose a marksman fires 100 rounds at a target. If taking the middle point of the

target as our centre, we then describe a circle so that the best 50 shots are within it, it will be an even chance, if the marksman fires his 101<sup>st</sup> shot, whether that shot goes outside or inside the circle. The radius of the circle represents graphically the magnitude of the probable error.

In the case of the Simplon tunnel, the mean probable error in determining the direction of the tunnel was 0.47 second. This error would give a lateral divergence of about 5 centimetres ( $1\frac{31}{32}$  inch) at 20 kilometres (12.43 miles).

But this probable error is only that due to want of accuracy in measuring the angles of the triangles. To this we must add the errors inside the tunnel itself, in continuing the centre lines from point to point up to the middle. The magnitude of these errors cannot be ascertained with the same accuracy as in the former case. Some information is, however, obtained by repeated determinations of the distance of the axis from one and the same bench mark.

Thus in the case of bench mark 5, which is about 700 metres (765 yards) from the north end of the tunnel, the following results were obtained :

1 <sup>st</sup> determination, axis to bench mark . . . . .	110 millimetres ( $4\frac{5}{16}$ inches) in plan.
2 <sup>nd</sup> — — — — —	100 — ( $3\frac{13}{16}$ — ) —
3 <sup>rd</sup> — — — — —	105 — ( $4\frac{1}{8}$ — ) —
5 <sup>th</sup> — — — — —	117 — ( $4\frac{5}{8}$ — ) —
6 <sup>th</sup> — — — — —	143 — ( $5\frac{5}{8}$ — ) —
7 <sup>th</sup> — — — — —	115 — ( $4\frac{17}{32}$ — ) —
Average. . . . .	115 millimetres ( $4\frac{17}{32}$ inches) in plan,

and this always towards the north-east. This, by equation

$$\rho = \frac{2}{3} \sqrt{\frac{[vv]}{n(n-1)}},$$

gives a mean probable error of  $\pm 4$  millimetres ( $\frac{5}{32}$  inch) in the position of the axis.

Similarly in the following cases :

Mark 11, 1,900 metres (1 mile 318 yards) from entrance. . . . .	$\rho = \pm 7$ millimetres ( $\frac{9}{32}$ inch), from 4 determinations.
— 18, 3,300 — (2 miles 90 yards) — — . . . . .	$\rho = \pm 6$ millimetres ( $\frac{1}{4}$ inch), from 5 determinations.
— 24, 4,500 — (2 miles 1,400 yards) from entrance. . . . .	$\rho = \pm 11$ millimetres ( $\frac{7}{16}$ inch), from 4 determinations.

These results are shown graphically in figure 1. From them it may be concluded that if at a distance of 4,500 metres (2 miles 1,400 yards) the error in fixing the axis is 1 centimetre ( $\frac{3}{8}$  inch) in round numbers, it will amount to between 2 and 3 centimetres (between  $\frac{25}{32}$  and  $1\frac{3}{16}$  inch) at 10 kilometres (6 miles 375 yards).

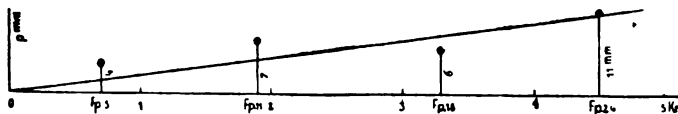


Fig. 1.

Explanation of German term : Fp. = Bench mark.

Similar results were obtained on the south side :

Mark 2, about 500 metres (545 yards) from entrance . . .	$\rho = 4$ millimetres ( $\frac{1}{32}$ inch), from 4 determinations.
— 9, — 1,900 — (1 mile 318 yards) from entrance .	$\rho = 4$ millimetres ( $\frac{1}{32}$ inch), from 4 determinations.
— 14, — 2,900 — (1 — 1,410 — ) — .	$\rho = 8$ millimetres ( $\frac{1}{16}$ inch), from 4 determinations,

and the corresponding error in the middle of the tunnel will also be between 2 and 3 centimetres (between  $\frac{3}{32}$  and  $1 \frac{3}{16}$  inch).

Now, as according to the laws of probability, the total probable error is not equal to the sum of these errors, but equal to the square root of the sum of their squares

$$R = \sqrt{\rho_1^2 + \rho_2^2 + \rho_3^2},$$

we have, in the case we are considering,

$$R = \pm \sqrt{5^2 + 2.5^2 + 2.5^2} = \pm 6 \text{ centimetres } (2 \frac{3}{8} \text{ inches}).$$

It follows that the errors due to the alignment inside the tunnel itself only have a very small effect on the total error.

But this calculation is only applicable if the errors in the alignment are accidental, that is to say, are sometimes positive and sometimes negative, and are not always of the same sign. The preliminary checking work carried out after the two tunnel ends met, enable us to conclude that errors of the last kind can have had but little influence (theory gives 6 centimetres [ $2 \frac{3}{8}$  inches], and the measurements made, as we have seen, show 5 centimetres [ $1 \frac{3}{16}$  inch]), although such a favourable result could by no means have been expected, considering the phenomena observed during the earlier alignment work.

Among these we may mention the singular mirage which at kilometres 3 to 5 (miles 1.9 to 3.1) north side, made the cross-section of the gallery appear not square but like a long rectangle, rounded at top and bottom, and which also caused two lights to be seen from the observatory instead of one.

No doubt errors of the same sign, produced by uniform currents of air, account for the fact that when setting out that 8<sup>th</sup> mark on the north side, when sixteen readings were taken, the sighting line diverged each time more to the same side, instead of sometimes to the right and sometimes to the left. Thus it was observed at kilometre 6.700 (mile 4.163) of the tunnel, after the instrument had been directed at a fixed light and finally adjusted, that in order to get a light about 2 kilometres (1.24 mile) further off, further in the tunnel, into the same line, it was necessary to give a lateral adjustment which amounted, on the average, in the case of :

Observations 1 to 4 . . .	to 34 millimetres ( $1 \frac{11}{32}$ inch), as measured from the mark adopted.
— 5 to 8 . . .	to 25 — ( $\frac{31}{32}$ — ), — — —
— 9 to 12 . . .	to 23 — ( $\frac{29}{32}$ — ), — — —
— 13 to 16 . . .	to 15 — ( $\frac{19}{32}$ — ), — — —

Thus the average position of the lamp approached the bench mark more and more.

The levelling operations gave a relatively less favourable result than the alignment : the final result being 9 centimetres ( $3 \frac{17}{32}$  inches) of error.

At the two ends of the tunnel the bench marks of the Swiss survey were taken as starting points. The line from Brigue to Iselle, over the Simplon pass, was surveyed twice, first in 1870, and then in 1873. The two levelling operations showed a difference of 116 millimetres ( $4 \frac{9}{16}$  inches). In spite of this difference, which is excessive for the accurate levelling of 46 kilometres (28.5 miles), the mean was taken as the height of the bench marks concerned.

In 1898-1900, the greater part of these levelling operations were checked, and the new results showed that the difference in height between Iselle and Brigue was 61 millimetres ( $2 \frac{13}{32}$  inches) less than that assumed in setting out the tunnel levels; but in order to avoid confusion, no correction was made in the height figures. Taking this into consideration, the error previously mentioned is increased from 9 to 15 centimetres ( $3 \frac{7}{32}$  to  $5 \frac{29}{32}$  inches). It was assumed as probable that the error of the new levelling operations over the mountain would not exceed between 2 and 3 centimetres (between  $\frac{25}{32}$  and  $1 \frac{3}{16}$  inch); this would thus leave a total error of between 12 and 13 centimetres (between  $4 \frac{11}{16}$  and  $5 \frac{1}{8}$  inches) in the levelling of the tunnel. Taking the increase of error in extending levelling operations as proportional to the square root of the distance, this gives an error of nearly 3 centimetres to the kilometre (1.90 inch to the mile).

Now, when the chief bench marks were fixed, each solution of the tunnel was levelled twice, at first as a rule in the first drives made, and then a second time when the part in question was completed and the final bench marks were fixed. In this way, a length of about 8 kilometres (5 miles) from either entrance was checked, and only the middle 4 kilometres (2.5 miles) had to be dealt with. The error in all the sections checked was considerably less than the 3 centimetres to the kilometre (1.90 inch to the mile) as mentioned above. Hence the only possible sources left, of a greater error, are either in the middle 4 kilometre (2.5 mile) section or else changes inside the tunnel must have had an unfavourable action on the results. The tables given below show the alterations observed at different times during the two sets of levelling operations.

These differences cannot be due to errors in levelling, as each level was checked by using two staffs simultaneously, and these could be compared together. The difference never amounted to more than a few millimetres per kilometre.

I also wish to make some remarks on the length of the tunnel. As I have already stated, no measurements, as far as I know, have been made since the preliminary ones taken when the two ends met. At that time it was found that the ends met from 1 to 2 metres (3 ft.  $3 \frac{3}{8}$  in. to 6 ft.  $6 \frac{3}{4}$  in.) sooner than was expected. Such a result, supposing it is confirmed by accurate measurements from the last definite bench marks, cannot be attributed to errors in triangulation only. No special base line was measured in order to determine the length of the Simplon tunnel, as is often done. The side of a triangle of the existing federal survey was taken instead. Calculations based on the errors of the angles measured (*i. e.*, of the angles of the Simplon tunnel system of triangles) showed that the probable error in the total length of the tunnel was 10 centimetres ( $3 \frac{15}{16}$  inches). But the side taken itself has errors, which increase the probable error in the length of the tunnel to 56 centimetres (1 ft. 10 in.). Another increase in this error, results from the uncertainty of the lengths measured inside the tunnel. These were at first measured by rods, the length of which was carefully checked before and after each measurement. This method gave good results; the measurements made agreed, on the average, to within 3 centimetres per kilometre (1.90 inch per mile). But it takes much time and a large staff is required; therefore it was replaced, later on, on the north side, by measurements made with a wheel 3 metres (9 ft.  $10 \frac{1}{8}$  in.) in circumference. These latter measurements were only carried out up to the end of the completed straight track, in the finished part of the tunnel; the wheel was run over the western rail. After running it four times over a given section, a probable error of about

LEVELLING FROM THE SOUTH.				LEVELLING FROM THE NORTH.			
Bench mark.	December, 1902.	December, 1903.	REMARKS.	Bench mark.	April, 1901.	December, 1901.	REMARKS.
III	663·502 metres (2,176 ft. 10 <sup>10</sup> / <sub>32</sub> in.).	663·502 metres (2,176 ft. 10 <sup>10</sup> / <sub>32</sub> in.).		15	690·949 metres (2,266 ft. 11 <sup>1</sup> / <sub>4</sub> in.).	690·949 metres (2,266 ft. 11 <sup>1</sup> / <sub>4</sub> in.).	6 millimetres ( <sup>1</sup> / <sub>4</sub> inch) lower.
25	663·821 metres (2,177 ft. 11 <sup>5</sup> / <sub>32</sub> in.).	663·835 metres (2,177 ft. 11 <sup>21</sup> / <sub>32</sub> in.).	14 millimetres ( <sup>9</sup> / <sub>16</sub> inch) higher.	18	694·953 metres (2,270 ft. 2 <sup>3</sup> / <sub>4</sub> in.).	694·947 metres (2,270 ft. 2 <sup>1</sup> / <sub>2</sub> in.).	16 millimetres ( <sup>41</sup> / <sub>64</sub> inch) lower.
IV	670·829 metres (2,200 ft. 11 <sup>5</sup> / <sub>16</sub> in.).	670·843 metres (2,200 ft. 11 <sup>11</sup> / <sub>16</sub> in.).	14 millimetres ( <sup>9</sup> / <sub>16</sub> inch) higher.	19	692·490 metres (2,271 ft. 11 <sup>57</sup> / <sub>64</sub> in.).	692·474 metres (2,271 ft. 11 <sup>1</sup> / <sub>4</sub> in.).	20 millimetres ( <sup>51</sup> / <sub>64</sub> inch) lower.
				22	693·524 metres (2,275 ft. 4 <sup>39</sup> / <sub>64</sub> in.).	693·504 metres (2,275 ft. 3 <sup>11</sup> / <sub>16</sub> in.).	17 millimetres ( <sup>21</sup> / <sub>32</sub> inch) lower.
				23	693·855 metres (2,276 ft. 5 <sup>11</sup> / <sub>64</sub> in.).	693·838 metres (2,276 ft. 4 <sup>89</sup> / <sub>64</sub> in.).	
	December, 1903.	December, 1904.			December, 1901.	April, 1903.	
29	674·602 metres (2,213 ft. <sup>5</sup> / <sub>8</sub> in.).	674·602 metres (2,213 ft. <sup>5</sup> / <sub>8</sub> in.).		35	698·754 metres (2,292 ft. 6 <sup>1</sup> / <sub>2</sub> in.).	698·754 metres (2,292 ft. 6 <sup>1</sup> / <sub>2</sub> in.).	18 millimetres ( <sup>45</sup> / <sub>64</sub> inch) higher.
30	676·240 metres (2,218 ft. 8 <sup>1</sup> / <sub>16</sub> in.).	676·261 metres (2,218 ft. 8 <sup>1</sup> / <sub>16</sub> in.).	21 millimetres ( <sup>13</sup> / <sub>16</sub> inch) higher.	37	699·406 metres (2,294 ft. 8 <sup>5</sup> / <sub>16</sub> in.).	699·424 metres (2,294 ft. 8 <sup>5</sup> / <sub>16</sub> in.).	5 millimetres ( <sup>13</sup> / <sub>64</sub> inch) higher.
V	677·833 metres (2,223 ft. 10 <sup>11</sup> / <sub>16</sub> in.).	677·839 metres (2,223 ft. 11 <sup>1</sup> / <sub>16</sub> in.).	6 millimetres ( <sup>1</sup> / <sub>4</sub> inch) higher.	38	699·880 metres (2,296 ft. 2 <sup>3</sup> / <sub>16</sub> in.).	699·885 metres (2,296 ft. 3 <sup>1</sup> / <sub>16</sub> in.).	6 millimetres ( <sup>1</sup> / <sub>4</sub> inch) lower.
32	678·845 metres (2,227 ft. <sup>11</sup> / <sub>16</sub> in.).	678·844 metres (2,227 ft. <sup>11</sup> / <sub>16</sub> in.).		40	700·603 metres (2,298 ft. 7 <sup>9</sup> / <sub>16</sub> in.).	700·597 metres (2,298 ft. 7 <sup>9</sup> / <sub>16</sub> in.).	

10 centimetres per kilometre (6·34 inches per mile) could be assumed. The middle section of 4 kilometres (2·5 miles) has never yet been made the subject of careful measurement. It was only measured by ordinary rules, for the ordinary constructional purposes; and it may therefore be assumed to have a probable error of 30 centimetres per kilometre (1 ft. 7 in. per mile).

Owing to these different errors inside the tunnel, the probable error due to the triangulation, which we have taken as 56 centimetres (1 ft. 10 in.), is increased, in round numbers, to 1 metre (3 ft. 3  $\frac{3}{8}$  in.). The reason for a greater error in the length is very probably to be found in errors of the same sign inside the tunnel, for instance in errors in checking the length of the measuring rods or errors produced by unrecorded changes of temperature in the wheel, which would produce changes in the length of the circumference.

On August 15 the final measurements are to be taken. The results then obtained will enable definite conclusions to be arrived at as to the still dubious points.

*Supplementary note.* — The final measurements were at last made on August 14 and 15, 1905, although the conditions in the middle part of the tunnel, as yet uncompleted, were not very favourable for the operations concerned. At the different points on the south side, where there were such great difficulties before the two ends joined, hot water still enters in large quantity and produces a thick mist. Ventilation is effected by a strong current of air forced into tunnel I from the north. All the cross-drives of the north side are closed, so that the air flows towards the south, improved by a second current of air which is forced into tunnel II from the south, passes through the last south cross-drive and then goes to the south through tunnel I.

The operation of checking the alignment of the axis of the tunnel was commenced at the north side at about 6,700 metres (4 miles 290 yards) from the entrance. In the first place a point was determined at 9,600 metres (5 miles 1,700 yards), at nearly the highest part of the tunnel; then another, 900 metres (984 yards) further. Here the section began where the mist interfered. It was hardly possible to take sights at a greater distance than 180 metres (197 yards), and here a point was marked on an iron sleeper to show, provisionally, the position of the centre line as continued from the north.

Then, starting from the south, the centre line was produced to the same point. The final sights had to be taken at 95 and 65 metres (104 and 71 yards). The two centre lines differed by 202 millimetres (7  $\frac{1}{32}$  inches). The one from the south was to the east, the one from the north to the west. The divergence is thus greater than thought at first. The difference between the two results is due to the fact that on the first occasion, after the foggy part had been traversed, the measurements were extended to the first bench mark to the north. Subsequent measurements showed that this mark was between 16 and 17 centimetres (between 6  $\frac{5}{16}$  and 6  $\frac{11}{16}$  inches) to the west of the centre line from the north. It is also possible that there may have been some changes in the bottom of the tunnel after that mark was fixed.

As regards the height, the previous measurements were confirmed. The height of the same mark, when the levelling was from :

The north side, was . . . . .	698·768 metres (2,292 ft. 7 $\frac{3}{64}$ in.).
— south — — . . . . .	698·855 — (2,292 ft. 10 $\frac{15}{32}$ in.).
Difference. . . . .	0·087 metre (3 $\frac{17}{64}$ inches).

Finally, the length of the last section was measured and it was found that the total length between the starting points on the two sides was 19,755·52 metres (12 miles 485·29 yards); whereas the calculation based on the triangulation had given 19,756·31 metres (12 miles 486·15 yards) :

$$\begin{array}{r} 19,755\cdot52 \text{ metres (12 miles 485}\cdot29 \text{ yards).} \\ 19,756\cdot31 \text{ — (12 — 486}\cdot15 \text{ — ).} \\ \hline \text{Difference. . . . . } 0\cdot79 \text{ metre (0}\cdot86 \text{ yard).} \end{array}$$

These final results in no way modify the statements as made above concerning the sources of the errors.

---

# PROCEEDINGS

OF THE  
SEVENTH SESSION

WASHINGTON : MAY, 1905

---

2<sup>nd</sup> SECTION. — LOCOMOTIVES AND ROLLING STOCK.

---

[ 621 .137.3 ]

QUESTION VI.

---

## POOLING LOCOMOTIVES

---

*The use of two or more crews.*

*Advantages and disadvantages of the practice and the result of such common use with respect to the efficiency and the care of the locomotive.*

**Reporters :**

*United States.* — Mr. G. W. RHODES, assistant general superintendent, Burlington & Missouri River Railroad in Nebraska.

*Belgium, England and colonies, Holland, Denmark, Russia, Sweden and Norway.* — Mr. E. HUBERT <sup>(1)</sup>, administrateur des chemins de fer de l'État belge.

*Other Countries.* — Mr. C. BOELL, ingénieur en chef des mines, ingénieur en chef du matériel et de la traction des chemins de fer de l'État français.

---

(1) Since the receipt of Mr. Hubert's report, the Permanent Commission has to its sincere regret had to lament his death.

## QUESTION VI.

---

## CONTENTS

---

	Pages.
Sectional discussion . . . . .	1229
Sectional report . . . . .	1254
Discussion at the general meeting . . . . .	1254
Conclusions . . . . .	1259
Appendix : Corrigenda to the report No. 3, by E. HUBERT . . . . .	1260

### PRELIMINARY DOCUMENTS.

Report No. 1 (all countries, except United States, Belgium, England and colonies, Holland, Denmark, Russia, Sweden and Norway), by C. BOELL. (See the *Bulletin* of September 1904, p. 873.)

Report No. 2 (United States), by G. W. RHODES. (See the *Bulletin* of August 1904, p. 841.)

Report No. 3 (Belgium, England and colonies, Holland, Denmark, Russia, Sweden and Norway), by E. HUBERT. (See the *Bulletin* of February 1905, 1<sup>st</sup> part, p. 683.)

Vide also the separate issues (in red cover) Nos. 4, 5 and 50.

---

## SECTIONAL DISCUSSION

---

Meeting held on May 9, 1905 (morning).

---

MR. ED. SAUVAGE, PRESIDENT, IN THE CHAIR.

**The President.** (In French.)—Gentlemen, to day we have to consider the question of pooling locomotives upon which subject there are three reports before us.  
I beg to call upon Mr. Boell.

**Mr. Boell, principal secretary and reporter.** (In French.):

The report of which I have the honour to submit a summary has been drawn up from the data supplied by twenty-six managements, operating altogether 101,081 kilometres (62,810 miles) of railway, having about 21,900 locomotives, and belonging to eleven different countries:

Austria, Hungary, Spain, France, Italy, Switzerland, Roumania, Bulgaria, Luxemburg, Argentine Republic, Uruguay.

Of the 21,900 locomotives on the railways in question, 17,500 are on the average in use every day and 79 per cent of the latter are worked by a single crew.

The system of the *single crew* is thus much the most usual one; but in order to utilise the locomotives better (a condition the more necessary as in most countries men's working hours tend to become more limited) rather varied combinations are adopted, either permanently or temporarily, such as:

*Double crews;*  
*Multiple crews;*  
*Three-men service;*  
*Interpolated auxiliary crews;*  
*Complete pooling.*

The *double crew system* consists in having for each locomotive two crews, which run it alternately. This is, after the *single crew system*, the most general one; it is even more usual on most railways than the former system in the case of shunting locomotives, for which it is specially suitable.

It is also much used for suburban traffic (especially on the French Western & Northern railways) and on certain secondary lines with a shuttle service, *i. e.*, where a locomotive is continually going forwards and backwards.

In these cases, each locomotive, as a rule, does the same work every day; one crew takes one given shift during a certain number of consecutive days, and then after a periodic rest changes over to the other shift.

Then also a double crew is used, on many railways, when the time-tables make it possible to run certain main line services, both passenger and goods. In such cases, the locomotives as well as the crews are used turn and turn about, each turn of a locomotive corresponding to two turns of the crews.

Double crews make it possible to run the same service with fewer locomotives than if single crews only were used; thus double crews lead to a material economy of capital. The extent of that economy, however, depends on whether and to what extent the time-table makes it possible to organise double crews, and it has to be noted that this system makes it necessary to have more reserve locomotives available than the single crew system, to replace if necessary locomotives in actual use; for double crew locomotives, as a rule, do not have long stops during which minor repairs could be made without interfering with the service.

The double crew system thus makes it possible to get more work out of locomotives, to an extent which varies considerably with the conditions.

In order that it may be an advantage to have a double crew, it is of course necessary that the increased work of the locomotives is not attended with any worse utilisation of the staff. It is therefore, as a rule, not advisable to have double crews unless that system makes it possible to carry out the same service with the same number of men as the single crew system, but with a smaller number of locomotives.

As for the consumption of fuel, most of the managements consulted are of opinion that this is not greater with double crews than with single crews. Though indeed the average consumption while running may be slightly increased because each of the drivers does not fully profit by any economy he may effect, this increased expenditure is largely counter-balanced by the economy resulting from the otherwise required frequent lighting of the fires and long stops of engines in steam, an economy which the Hungarian State Railway estimates at 5 p. c.

The observations I have made on the French State Railway, lead me to believe that the economy of fuel resulting from the double crew system can in certain cases become a very appreciable one, but that it depends essentially on how the number of trains and their time-table lend themselves to the utilisation of the locomotives by the single or the double crew system.

Most of the managements agree in observing that the double crew system results in an increase in the consumption of lubricating materials on the locomotives, as each driver has a tendency to use excess, to counteract any possible neglect on the part of his colleague. Some railways, it is true, state they have not observed any difference; this is no doubt due to the fact that an economy results from doing away with long stops and this compensates more or less for the increase previously noted.

I am led by my own personal observation to conclude that the amount of lubricant should be practically the same, per kilometre of run, with the double crew and the single crew systems.

As for the cost of maintenance per kilometre of run, the nearly general opinion is that the double crew system gives less good results than the single crew system. A few railways, it is true (particularly the Orleans Railway and the French Western Railway), think that the difference is hardly appreciable.

The French Eastern Railway, however, declares that the increased cost of maintenance, hardly appreciable on short suburban runs, was very noticeable on some of the main line services where the double crew system had been applied.

Most of the disadvantages mentioned by the Eastern Railway, do not necessarily exist in the case of the double crew system, even on long distance trains. In many cases, the train time-tables make it possible to allow every day sufficient time for clearing out the tubes and the smoke-box, and it is always possible to put the locomotives out of service, after running a given number of days, in order to wash them out. Thus all depends on the individual conditions, and it seems it may be stated, that if a service can conveniently be run on the double crew system, the cost of maintenance of the locomotives is not appreciably higher than with the single crew system.

The chief difficulties arise from the employés. as each crew as a rule prefers to have a locomotive to itself, and not to have one jointly with another crew. Particularly when at one and the same locomotive shed some of the services are worked on the single crew system and others on the double crew one, the drivers of the latter are very apt to consider themselves less well treated than the former. But if they are made to understand that they can, if they cooperate well, gain rather larger premiums on the double crew system than on the single crew system, by a reduced consumption per kilometre, not only will that reduced consumption be realised, but the locomotives will be carefully looked after and consequently no abnormal expenditure for maintenances will be incurred.

The *multiple crew system* consists in having for a certain number of locomotives a certain greater number of crews, working turn and turn in an order which may vary considerably.

The double crew system which has just been described is in fact only a particular case of the multiple crew system, and is indeed the one most generally used.

Another particular and simple case is the *triple crew system*, often used for shunting locomotives, when these are used so much that two crews are not enough for one locomotive. The day is then divided into three eight-hour shifts, and each crew takes its shift in succession.

Generally speaking, it is agreed that apart from shunting operations, the multiple crew system is not advantageous from the points of view of consumption and of cost of maintenance of the locomotives. It has in fact all the disadvantages of the complete pooling system, which will be mentioned later on, and which in fact it much resembles. Except for shunting operations, it is never adopted unless it becomes necessary owing to a deficiency in the number of locomotives.

One particular case of the multiple crew system, and one which has the disadvantages of the system to a lesser extent, is that of the double crew with substitutes, used by the French Western Railway in some of its suburban services. In this particular case, say six locomotives are run, during the greater part of the day, by two crews each; in addition there are two extra crews, which run them, in succession, during certain definite hours. Thus there are actually fourteen crews for the six locomotives, and nevertheless twelve of those fourteen crews are always on the same locomotives. As the extra crews only do a very short shift every day with each locomotive, the results obtained are very nearly the same as with double crews, and the locomotives are utilised even better.

The three men service system consists in having three given men to run a given locomotive, namely a chief engine driver, an assistant engine driver who at some times acts as fireman and at others as driver, and a fireman. The daily run of the locomotives is divided into three periods during which it is worked :

- 1° By the chief driver and the fireman;
- 2° By the assistant driver and the fireman;
- 3° By the chief driver and the assistant driver.

This organisation makes it possible, under suitable conditions of service, to obtain the same

results as with a double crew, but having only three employés instead of four. But in order to make it possible, it is of course necessary that the total daily service of the locomotive, while too long for a single crew, is divisible in three periods, any two of which added together are not longer than the regular working hours of one employé.

The system is more specially adaptable for certain shuttle services on secondary lines, or for shunting operations extending over a certain number of hours.

The *interpolated auxiliary crew system* consists in utilising, for certain train services, locomotives whose actual crews are resting, and having them run by auxiliary crews.

In some cases, the auxiliary crews work in certain regular rotation, and then the system becomes a special case of the multiple crew system. In other cases, any crews available are used as auxiliary crews, as and when occasion arises, and then the system is a mixture of the single crew system and of that of complete pooling.

Some railways, for instance the French Eastern, only use this system to a very limited extent, in the case of local services of minor importance (shunting operations, extra services) at places where there is no locomotive shed.

Others on the contrary apply the auxiliary crew system very extensively and use auxiliary crews on many services generally run on the single or double crew system; principally in the case of composite trains and goods trains.

With this system, the utilisation of the locomotives is very complete. As for its economic results, they naturally depend on the extent of the period during which the auxiliary crews take charge of each locomotive, on the number of crews which run each locomotive, and on the time table of the service.

The *system of complete pooling* consists in not having any definite crew appointed to a given locomotive; it makes it possible to organise on the one hand the circulation of the locomotives taking only the necessary technical conditions into consideration and on the other, the work of the employés on the accepted basis laid down, without considering any connection between the service of a given locomotive and that of a given crew.

Only one of the railways which have supplied with information on the subject uses this system permanently and exclusively, and that is the St. Gothard Railway. It gradually applied this system during 1887 and 1888, and has kept to it since. If we compare the expenditures per gross ton-kilometre in 1886, before the introduction of the system, with those in 1889, after it had been generally applied, we find that :

- 1° The expenditure of fuel increased 5·5 per cent;
- 2° The expenditure of lubricant increased 42 per cent;
- 3° The expenditure for maintenance increased 11·6 per cent.

As however other factors affected this increase (*e. g.*, greater speed and heavier locomotives) it is difficult to determine what proportion is due to the pooling.

The other railways state that the results given by this system are but little satisfactory, and do not use it as a rule except in the case of goods trains, and then only when they are compelled to do so by having too few locomotives.

Thus the Adriatic Railway estimated that when it applied this system to a few of its services, previously run on the single crew system, the consumption of fuel increased 15 p. c. and that of lubricant 30 p. c. It also estimated that the increase in the cost of maintenance was at least proportional to that of the consumption of fuel.

The Paris-Lyons-Mediterranean Railway has been obliged, during fairly long periods, to apply

the pooling system in order to cope with sudden pressure of traffic; it observed an appreciable increase in the expenditure of fuel and lubricant, a considerable increase in the cost of maintenance and a reduction in the proper professional spirit of the drivers.

The French Midi Railway also, on two occasions, was compelled to apply this system extensively : from 1880 to 1884, on account of a sudden and unexpected increase of traffic, and in 1893, on account of new regulations as to the working hours of drivers and firemen. The system enabled it to carry out the service with a smaller number of locomotives (by 34 p. c.) than would have been necessary with regular appointed crews. The railway even organised depots from men without locomotives, to supply crews for running locomotives from other depots over given sections of their journey.

A comparison of the figures for the twelve months before the system was introduced, and for the twelve months during which it was applied, show that the average consumption of fuel by the locomotives in question, per kilometre, remained exactly the same. But care had been taken to let every driver have his own tender, and consequently his own special check on the consumption of fuel. In the case of tank locomotives, the amount of fuel was estimated, at each change of crew, by a higher official in the presence of the two drivers interested, and in case of dispute, each driver had the right to demand that the fuel should be unloaded and weighed in his presence. Without these precautions, which involved a considerable complication in the service, it is probable that the system would have resulted in an increased expenditure for fuel.

As for the cost of maintenance, the experience gained by the French Midi Railway from 1880 to 1884 showed that it had increased materially. During the years before, and after, the system was in use, the average cost of maintenance amounted to 0·056 franc per kilometre (0·865*d.* per mile). While the system was in use, this cost increased progressively as follows :

In 1880, it was . . . . .	0·056 franc (0·865 <i>d.</i> per mile).
In 1881, — . . . . .	0·066 — (1·020 <i>d.</i> — ).
In 1882, — . . . . .	0·071 — (1·097 <i>d.</i> — ).

Finally, the Midi Railway, while admitting that when traffic is specially congested, the system of having different sets of men is a valuable resource, concludes that the system should not be adopted permanently.

I am led by the foregoing considerations to the following conclusions :

1° The system of complete pooling always leads to a very appreciable increase in the cost per kilometre, and should consequently not be applied except in case of absolute necessity ;

2° It is better, in order to increase the utilisation of the locomotives, to adopt the system of interpolated auxiliary crews, or else that of multiple crews ; these are attended with infinitely smaller disadvantages ;

3° The double crew system is specially to be recommended, particularly for shunting, suburban and shuttle services, and even for some main line services ; for while this system results in a better utilisation of the locomotives than the single crew system, it makes it possible to realise a small economy of fuel without appreciable increase in the cost of maintenance ;

4° With these different systems, it may be of advantage, from the point of view of the expenditure of fuel, to let every driver have his own tender ; this, however, leads to a certain amount of complication and is not always feasible ;

5° The system of three-men service can under certain conditions be substituted with advantage for the double crew system ;

6° Finally, that systems other than the single crew seem not to be advisable in the case of fast and express trains, which require locomotives kept in good condition and to be wellknown to their drivers.

**The President.** (In French.) — I now call upon Mr. Hodeige to give us a summary of Mr. Hubert's report.

**Mr. Hodeige,** Belgian State Railways. (In French.) — Gentlemen, the honour of addressing this meeting has fallen upon me owing to the unexpected death of the author of the report on question VI for the different countries of Europe and for the British colonies.

Mr. Hubert, administrator of the Belgian State Railways, was a most distinguished official. He took part in the labours of the various sessions of the Congress prior to this one; many of you made his acquaintance and were in a position to appreciate his kindness of heart and his ability. I hope you will allow me to say how much I regret his loss. (*Hear, hear.*)

The detailed list of questions appended to Mr. Boell's report was sent out to ninety administrations in the following countries : Belgium, Denmark, Great Britain and Ireland (United Kingdom), India and the Colonies, Norway, Holland, Russia and Sweden. Fifty of them sent answers.

Of these fifty railway managements which sent answers to our list of questions sixteen, whose lines represent 28·85 per cent of the total mileage, only have single crews except in the case of shunting operations where several have double crews.

Of thirty-four other managements, who have more than one crew per engine, eight state that they only do so by force of circumstances and that they prefer single crews; if we add them to the first sixteen, we find that twenty-four managements, representing about 45 per cent of the total mileage prefer to have single crews without exception.

Of the twenty-six managements which normally have — in addition to the single crew system or not — more than one crew per locomotive, twenty have in daily use an average number of 12,576 locomotives, worked on the following systems :

8,249 single crew system ;
3,391 double crew system ;
100 treble crew system ;
659 multiple crew system ;
28 mixed systems ;
149 complete pooling.
<hr/> 12,576

Thus the single crew system has most partisans, in the sense that it is the one most frequently applied. But the profitable use of more than one crew per locomotive requires special conditions of working, of traffic, etc., which are not always to be found. It is even rare that the whole service of a railway can be carried out without applying at least to some extent the single crew system, the advantages and disadvantages of which we think it useless to summarize here, as they have been sufficiently set forth in the opinions expressed by the different managements in the information with which they have supplied us.

Next to the single crew system, it is the double crew system which is most often applied. The

large majority of the railways which apply this system regularly recognize that the advantages which result as regards the increase in the annual mileage of the locomotives, in the decrease and in the regulation of the working hours of the employes, and in the decrease of the lighting up and of the shed duties, are only attained at the cost of an increased consumption of fuel and of lubricants, and of a less good maintenance of the locomotives.

There is no unanimity on this point, for three important railways report a saving rather in the fuel and two others do not find that in this respect there is any difference between single and double crews. It even seems that in many cases the advantages exceed the disadvantages, for most of the railways which have double crews do not seek to reduce their number; there are even some who state that they want to extend the application of this double crew system.

The only instances of treble crews mentioned are in the case of shunting locomotives at very busy stations on three railways in Great Britain, one of which thinks that there is an increase in the cost of fuel, lubricants and maintenance, whereas the other two are silent on this point. The Cambrian Railway, although recognizing the disadvantages, has three crews on goods locomotives, but only when there are special conditions.

Multiple crews are principally used on the Swedish State Railway and on the New South Wales Government Railways, who both record an increase in the items mentioned above.

Mixed systems are only of very limited application, as we have just seen: the chief is to be found on the Norwegian State Railway, where in certain services there are three crews to two locomotives, or four crews to three locomotives, or else the three-man system is applied. In Russia, the Kharkov-Nicolaiev line also applies, but exceptionally, the three-man system which it does not recommend.

*Complete pooling* is scarcely in favour with nearly all the railways which we are considering. Only three apply this system as a regular thing; moreover, it must be mentioned that one of them, the Natal Government Railways, states that this system is only applied, by force of circumstances, because there is a want of locomotives and in every way prefers the single crew system which it considers best. The Taff Vale Railway, on the other hand, appears to be satisfied with it. Finally, the Transbaikal line (Russia) states that it is the small importance of the traffic on the line which has led to the adoption of the pooling system. Perhaps it may be partly also owing to the fact that the Transbaikal line, which is more than 1,200 kilometres (745 miles) in length, is at present only a single track railway connecting Lake Baikal and Manchuria, with a branch to Stretensk, the actual terminus to the north. This configuration of the line lends itself quite well to the application of the complete pooling system to the locomotives of the few trains, running very long distances, although it sometimes gives rise to difficulties in maintenance.

The London & North Western Railway (England) applies, in ordinary practice, the complete pooling system to optional trains and shunting locomotives; the Danish State Railway, to the latter only.

The Belgian Northern in Belgium, the Great Northern and Great Central in England, the Great Indian Peninsula and the Cape Government Railways, exceptionally apply the complete pooling system in order to meet a sudden rush of traffic; but they are but little satisfied with the system and do not recommend it. Finally, the Madras Railway, which had adopted it, for similar reasons, entirely abandoned it owing to its disadvantages.

Are these different observations of such a kind that a definitely unfavourable verdict on the complete pooling system may be pronounced? We do not think so. This system, in order to give the maximum advantages it can offer combined with the minimum disadvantages, requires a very special organization which cannot be developed from one day to the next for special cases or

temporary purposes. Consequently we are of opinion, that it would not be possible to determine its actual value except by examining the results obtained by important railways, applying it on their systems in a permanent and general way; which, as has been seen, has been in no way the case here.

**The President.** (In French.) — I believe I am right in thinking that Mr. Rhodes is absent and that he will not be present at our meeting. Perhaps one of the engineers present is prepared to give us a summary of Mr. Rhodes' report. If not I shall call upon Mr. Boell to read us a short summary of Mr. Rhodes' paper.

**Mr. Boell.** (In French.) — I propose to read the closing portion of Mr. Rhodes' report which contains the more important matters. As regards the rest delegates will kindly refer to the text of Mr. Rhodes' paper.

In hopes of determining what the general sentiment on this much discussed subject was on the railroads of the United States, Canada and Mexico, a circular of inquiry was sent to two hundred and seventeen members of the American Railway Association propounding various questions and asking for a contribution of any views that might be useful to your reporter. Only eighty-four replies were received which may be classified as follows :

Unfavourable to pooling . . . . .	48
Favourable to pooling. . . . .	36
	<hr/> 84

An interesting fact drawn out by these replies and one that we will have occasion to refer to later on, is that with some few exceptions, the lines unfavourable or that for various reasons do not pool engines, except in case of an unusual rush of business, are short lines or lines operated in a sparsely settled part of the country. Those that favour pooling are generally lines in the more thickly settled part of the country.

From the foregoing, it may be inferred that the general opinion about pooling engines today presents practically the same doubts and considerations that existed in its early history. One point alone seems to be settled. The attempt at long continuous runs with relay crews has with some few exceptions, chiefly passenger runs, been abandoned. This is largely due to a lack of uniformity in coal over different railroad divisions. Ash pans, grates, and fire-boxes become so clinkered up and the strains on the machinery, aggravated by surface conditions of the road-bed, make it so necessary that the working parts have roundhouse inspection and care that it has been found that a relay engine saves more time and makes better railroading than a relay crew.

The undoubted advantage of team work, as obtained by always having the same train crew behind the same enginemen, is becoming less and less practicable. Trainmen of today with the aid of automatic couplers, automatic brakes and increasing train speeds are able to turn in more mileage monthly than is possible with enginemen.

The enormous growth of the modern freight locomotive together with the increased train tonnage possibilities is already restricting the enginemen's mileage and especially affects that of the fireman, and it looks as though the advantages of team work by always having the same crew together is becoming less and less practicable every day. Where it can be practiced the advantages are so apparent that we cannot but commend it in the strongest way.

Why then is the question of pooling still an open one? Two chief points influenced the question thirty years ago and they have equal influence today :

1° It was and is not contradicted that pooling increases some engine expenses ;

2° The main advantage gained by pooling and which offsets these increased expenses is the decrease in interest account due to pooled engines.

We have no sympathy with those who argue that pooling, regardless of traffic conditions, does not increase engine expenses. Isolated cases may be cited where on account of exceptional conditions together with an increase in mileage, an economy is shown but for one such case on a line not burdened with traffic and with plenty of engines, there will be a dozen that will show no economy whatever; on the contrary the expenses will be increased. It is very important that this fact should be fully recognized. A failure to appreciate it, may involve some railroads in heavy expenses that are quite uncalled for. The superficial investigator knowing of the great success of pooling under some conditions, may assume that pooling is a general economic law in handling locomotives on railroads. No more serious mistake was ever made.

The essentials for a properly conducted engine pool are as follows :

1° An engine house inspector, or inspectors, whose duty shall be to report all work on incoming engines, which shall be checked up with the engineman's incoming report. Provision should be made to have all work properly attended to : neglect in this matter has done more to injure and discredit pooling than any other feature. Men in a pool when they report work and ten days later get on the same engine and find the same thing which requires repair still not attended to, drop into careless habits. There are too many cases of " I reported that leaky boiler check the last time I had this engine and here it is not repaired yet. " If a regular man had the engine he would raise objections until the work as reported was done. In a pool, the foreman or workman has a chance to say : " Another man will get this engine who will not know whether this work was reported or not " ;

2° A sufficient engine house force to attend to all cleaning of engines both below and above the footboard and in the cab. Provision also to be made for cleaning and filling all engine lights ;

3° All lantern to be maintained and kept under a tool room check system. Under this system, lanterns are pooled in the same way that engines are and each incoming engine crew has to account for its lanterns. The number of lanterns under this system is materially minimized through a large proportion of these being in constant service ;

4° Heavy engine tools to be kept in a sealed box on the engine, the seal to be carefully inspected on each arrival. Each engineman to be supplied with a portable tool box ;

5° A kit of oil cans is assigned to each engineer. These receptacles are taken off the engine by the fireman at the end of each trip and placed in the oil room where they are properly filled, cleaned and cared for ;

6° A set of enginemen's lockers or boxes should be at the disposal of the engine crew.

In conclusion then let us clearly understand that no hard and fast rule can be made that will fit all railroads in the matter of pooling engines. The conditions of traffic together with the amount of equipment as existing on each road, alone can determine the expediency for or against pooling.

**The President.** (In French.) — The discussion on all three reports is now open.

I have no doubt that Mr. Gibbs of the Pennsylvania on which the subject of pooling has been particularly studied will be able to furnish us with some interesting information on the subject.

**Mr. A. W. Gibbs, Pennsylvania Railroad.** — I have very little to say upon the subject of pooling locomotives, which originated about twenty-eight years ago on our road, owing to a scarcity of locomotives, and is now in very general use. The only exceptions are certain passenger engines which are single crewed. Still more passenger engines are double crewed, and a very few freight crews which are single. I think with us there is no question that the pooling of locomotives has had a tendency to lower the general standard of the locomotive operation — that there is a general lack of interest and care on the part of every one as to the condition of the locomotive, and at the present time our management is largely increasing the number of locomotives so as to carry on a trial of assigned locomotives, either single or double crewed, on certain of our divisions.

We run across some very serious difficulties, and I may ask some of the gentlemen, especially our foreign friends, to explain some points. For instance, our roundhouse, our locomotive terminals, are supposed to be adequate when we have a roundhouse facility equal to, say, one quarter of the engines handled at a terminal. For instance, if you are handling two hundred engines through a terminal, you would want from forty to fifty covered pits, a roundhouse of at least forty stalls. This is an arbitrary division, and sometimes the percentage will run higher. When we run to a large number of engines passing through one terminal, two hundred engines or more, it is practically impossible to house them. They have to stand out of doors. The question we have not solved is how to take care of the engines which are standing while the crews are resting. I would like to hear from some of my colleagues on that subject. The second point is how to take care of the crews when the engines are in the shops. In former days, it was not an uncommon practice when a locomotive was sent to shop, that the locomotive engineer should also go to the shop and work on his locomotive, receiving shop pay. Later, the custom was established, during the period that a locomotive was in shop, of giving the engineer any unassigned locomotive to use. Later, on some roads the practice is that when an engineer wears out one locomotive, he is assigned to some other coming from the shop. It is very evident that the incentive to care for the engine is less in the last case than in the first. None of the papers mention how these matters are managed. In short, we are in the position of people who pool our engines habitually from force of circumstances; but that we recognize the contrary practice seems to be attended with a much less cost of maintenance and better operation. So that I am really in the position of a questioner rather than one who can make any valuable contribution to the discussion.

**Mr. Flobert, Spanish Northern Railways.** (In French.) — One short question, if you will allow me. Do American engine drivers receive premiums for saving coal?

**Mr. A. W. Gibbs.** — On our road, formerly yes, but at present, no. The inaccuracy in charging coal to the locomotives and crediting that on the tender at the end of the run is so considerable, together with the difficulty of establishing an equitable basis by which the coal consumption can be compared, was so great that we came to the conclusion that the premium system was very much of a farce, and it was given up for those reasons.

**Mr. Tordeux,** French Eastern Railway. (In French.) — As regards the system of engine-driving adopted, we must take into consideration the allowance of premiums, which makes the men take an interest in maintaining their locomotives in good condition. In France, we give premiums for saving coal and oil and moreover, at least on the Eastern Company, maintenance premiums. The latter depend for their amount on the mileage run by the men with their engine and the individual allowance is proportionately high according as the total distance run by the engine since its being sent to the main shops for repair is greater.

On the Eastern Company, we set our faces strongly against pooling as a general policy and we do not have recourse to this system unless we are absolutely obliged to meet a sudden enormous increase of traffic. And we always do our very utmost to see that this system is only temporarily employed and that pooling should never be practised as a regular thing.

In theory, we favour the single crew system, which has always given us most satisfactory results. This does not however mean that we refuse entirely to employ the double crew system, which in some cases has proved very satisfactory and economical. But these instances are comparatively few and, to prove advantageous, the double crew system ought to be used only with discretion. For, if the staff is to be properly utilized, engines manned thus ought not to make too lengthy runs and there must not be too long intervals when they are lying idle between the trains they are hauling. Moreover, it is essential that these engines should not be put on too arduous a service, so that small current repairs may be reduced to trifling dimensions. When employed in these circumstances in the suburbs of Paris and of other large cities, the double crew system has given us great satisfaction.

Apart from these conditions, the double crew system has seemed to us of small advantage, and during the Paris Exhibition of 1900, we had an experience on our lines that I should like to bring to your notice.

During that year, we had to carry an enormous number of passengers to Paris and we had therefore to put on a certain number of extra expresses. The result was that our stock of express engines proved insufficient. To meet this contingency we manned our engines with double crews in one of our roundhouses. But these engines, which were worked to their full power, broke down so often that any economy there might be in working a double crew disappeared. In fact we only realized a very small saving in the number of locomotives working, for whereas when a single crew is being used we allow only an extra supply of 10 to 15 per

cent for repairs and displacement, we found ourselves obliged, in our double crew service, to allow between 50 and 60 per cent owing to the frequency of the breakdowns that occurred in the engines being worked on this system. Finally, despite all the care that could be taken, the express engines with double crews were so much out of condition, that they had to be sent to the main repairing sheds after running from 100,000 to 150,000 kilometres (62,000 to 93,000 miles) less than engines of similar patterns which had been worked with a single crew in another roundhouse where nevertheless they had been doing rather harder work.

Since that time and enlightened by this result, we have had recourse to double crews only where they offered obvious advantage and everywhere else we have as a general rule used nothing but the single crew system — a decision upon which we have no reason to do other than congratulate ourselves.

**Mr. Asselin, French Northern Railway. (In French.)** — If I understood Mr. Gibbs rightly, he wants to know four things about which Mr. Tordeux has perhaps not replied definitely.

Mr. Gibbs asks :

- 1° How are the engines looked after while they are standing in the roundhouse?
- 2° Room for how many engines under cover must be allowed in the roundhouse?
- 3° How are crews occupied while their engines are undergoing repairs?
- 4° When engines come out from the general repair shops, how are they distributed?

I will try to reply briefly to these different questions. The first concerns the maintenance of engines while they are idle in the roundhouse.

As a rule, the engines are entrusted to gangs of stokers attached to the roundhouse who look after them as long as they remain there.

It is the driver who inspects his engine when it gets into the roundhouse and points out what repairs are required. We duplicate this inspection by means of special foremen who check the statements of the drivers, so as to make sure that the necessary repairs have been noted properly, and to see that these repairs are properly carried out while the engine is in the roundhouse.

Secondly, what do we do with drivers and firemen whose engines are laid up for one or more days to allow of the necessary repairs being carried out?

We generally have a certain number of extra engines in service. These engines are handed over in turn to the crews whose locomotives are laid up. For several days then, these crews take over the extra engines. When their own engines have been repaired either at the large shops or in the roundhouse, they return and again take possession of the engines which belong to them.

In passing, allow me to say that in our roundhouse shops we undertake repairs of greater importance than those which are carried out in America in similar roundhouses.

So in a general way our drivers, so far as is possible, always stick to their own engines. If one is laid up for repairs, the driver, for a time, takes over another but returns to his own engine as soon as it has been overhauled.

As regards the amount of room under cover in comparison with the number of engines, we have no fixed rule. I know roundhouses where there is, so to speak, no cover and where the engines are stalled almost entirely in the open. On the average, however, the covered stalls amount to 50 per cent of the number of engines accommodated. I say on the average, because there are points where the covered accommodation is greater and others where it is much less. This arises from the fact that sheds in the roundhouses do not always grow as fast as the traffic. The whole matter therefore depends often on the date at which a particular roundhouse was built.

Now I should like to ask a question which suggested itself to my mind while reading Mr. Rhodes' report.

It is there stated that generally speaking in America, there has been a decrease in the mileage run by engines. I should like to know what limits American engineers allow, in passenger service, and in goods service, without stopping and with single crew.

**Mr. A. W. Gibbs.** — I will take an instance illustrating the point I raise, which will probably make the matter clearer. Two divisions of our railroad centre at Altoona. These two divisions have 686 freight locomotives, of which number from 450 to 500 go to this one terminal at Altoona. The roundhouse has but 52 stalls and something like 203 locomotives are handled each day at that point. These engines are in the double-pool, the triple-pool, or the multiple-pool. From present indications it looks as though standing room would have to be provided for 200 locomotives.

The question of finding track room on which to stand so large a number of locomotives is almost appalling, and this condition prevails not only at Altoona, but at other terminal points. It is one of the serious difficulties in the way of establishing the single crew system. We think that possibly some of our American colleagues may have conditions even worse than that.

**Mr. Asselin.** (In French.) — If I am not mistaken, Mr. Gibbs finds it impossible to reply to the question I asked him.

We have engines which belong to definite roundhouses. Under the pooling system employed on the Pennsylvania, there are no engines allocated to roundhouses. Therefore we cannot reckon on similar bases, ours being quite different.

When I said just now that we had nearly 50 per cent of the stalls, under cover, I was not counting all the engines that arrive at the depot, for then of course the proportion would be much smaller.

**The President.** (In French.) — Is not every engine attached to a special roundhouse in America?

**Mr. A. W. Gibbs.** — No, not at present. The common pooling system is to have a certain number of engines assigned to a division. They may be single crewed, double crewed or multiple crewed. In times of stress the large roads transfer locomotives with very little warning from one division to another. The crews are allocated, as Mr. Asselin states. The locomotives, when assigned, would probably be allocated in the same way.

**The President.** (In French.) — I should very much like to hear answered Mr. Asselin's question as to the longest distance run by an engine without being taken off and exchanged for another; this applies both to goods trains and passenger trains.

**Mr. A. W. Gibbs.** — In the paper by Mr. Rhodes is given a report from the Richmond & Danville Railroad. In this latter report are stated two continuous runs, each of 140 miles, or 280 miles straight away. That long run on the Richmond & Danville was, at the time when I was connected with that road, made with two crews. The distance, if I recall it correctly, is 140 miles from Richmond to Danville, and another 140 miles from Danville to Charlotte. The engineers left the locomotives at Danville, but the locomotives went right through with the same train. There may be longer continuous freight runs on other American roads, but I am not aware that such is the case.

**Mr. Sabouret, French Western Railway.** (In French.) — From the summaries of the reports to which we have listened and the data with which we have been supplied, I gather that there is a very marked difference between American practice on the one hand and the French methods on the other hand which likewise apply to most European systems.

Pooling is the American practice; the individualized crew is the practice preferred on all European lines.

This difference is above all things due to the comparative cost of fuel in the two places. For if we consider the three principal items of haulage expenditure, we find that first there is the expenditure on the staff, secondly cost of purchase and maintenance of locomotives and thirdly cost of fuel besides expenditure on oil.

Pooling and a single crew mean that the staff is about equally utilized. This utilization depends on other considerations than the system of driving followed; it depends more upon the regulations in force with regard to hours of labour.

The utilization of the locomotive is affected by very different circumstances in Europe and America. In the United States, the initial cost of a locomotive is much lower, and it would seem that the pooling method of working possesses no very distinct advantage in this respect as compared with the system practised in Europe. Pooling, which results in getting more work out of the engine, is evidently less advantageous than individualisation in the country where the locomotive costs less. But on the other hand, pooling largely increases the cost of maintenance. The engine keeps in much better repair with a special crew and in this way the European

practice is more advantageous than the American. On the whole, perhaps these two sources of expenditure practically balance each other.

Now comes the question of fuel. In the United States, coal costs from 1 to 2 dollars on the tender. In France, the cost of fuel amounts to as much as 3 and even 4 dollars on the tender. The difference is considerable and is enough to justify the preference shown in France and in most European countries for the system of special crews which obviously is more suited than any other to saving the consumption of fuel.

In order to arrive at a fairly accurate idea of the importance of the saving in fuel, we need only compare these two items of expenditure : fuel and driving. In France, coal costs nearly double the wages of the crew. I should like to know what the proportion is between these same expenses on American lines.

After careful consideration, it is obvious that the widely different practice followed in America is due to the very different conditions that hold good on the two continents.

**The President.** (In French.) — Can anyone answer Mr. Sabouret's question?

**Mr. A. E. Mitchell,** Lehigh Valley Railroad, United States. — On the Lehigh Valley in freight train service our cost for coal and for enginemen and firemen for the year ending June 30, 1904, was as follows :

Fuel per locomotive-mile . . . . .	0.1297 dollar.
— per 1,000 ton-miles . . . . .	0.1781 —
Enginemen and firemen per locomotive-mile . . . . .	0.0730 —
— — per 1,000 ton-miles . . . . .	0.0873 —

During the same period on the Northern Pacific Railway the costs were as follows :

Fuel per locomotive-mile . . . . .	0.1582 dollar.
— per 1,000 ton-miles . . . . .	0.1856 —
Enginemen and firemen per locomotive-mile . . . . .	0.0892 —
— — per 1,000 ton-miles . . . . .	0.1047 —

On roads with which I have been connected in the past the cost of fuel is about equal to the combined wages of the enginemen and trainmen. Of course, these figures are based on the large locomotives we have today, in addition to the small ones which are necessarily on each road and are approximately average figures.

**The President.** — We should much like to have the opinion of some of the representatives of the railways of Great Britain on this subject.

**Mr. Dugald Drummond,** London & South Western Railway. — I should like to say a word with reference to the practice of pooling in England. Pooling in England is the exception, not the rule. The exception is usually applied to all large cities, more especially to London, where we have a population of 6,500,000. On the railway with which I am connected we have one hundred and ninety-five engines pooled,

but we take care that two sets of men continue to take charge of that engine throughout the whole year. So far as regular working is concerned, we never pool unless through shortness of engines at a station where an accumulation of traffic may overtake us, but we always, as a rule, have sufficient engines to do that work. The switching engines which we have at the several depots cost more for maintenance, cost more for fuel than the ordinary engines worked by one set of men constantly, because these engines are in the charge of no one set of men; there is one set of men on today and another set of men on tomorrow. I find the consumption of coal is fully 10 per cent more on these engines, and the cost of repairs equally so. I have often got on an engine, and if it was not in the condition I thought it should be, I say to the engine driver — how is it your engine is in this condition? The invariable reply is — I received it in this condition; it is not my own engine; this is the first time I have had it.

I am sure no engineer of experience in this room can lay down a hard and fast rule for pooling engines. On all the railways, the work is so varied, and you cannot do it unless there is a large suburban traffic. My experience is where you have that condition, it is always best to have two sets of men on that engine and keep them on it. We run 3,900 miles per month in the suburban service with these double crewed engines. We find very little difference in the cost of repairs, per engine, per mile, and no difference in the cost of coal. I attribute that to keeping both the men who are on the engine equally responsible for it, both for the consumption of fuel and the condition of the engine.

We have a system which may be of some interest to you. We never allow an engine to leave the shed solely on the examination of a driver. We have in each shed what is called an experienced inspecting mechanic, whom we can trust to go over the engine before it leaves the shed, which prevents a great number of failures in the working of our traffic. In the use of fuel we give a premium, but the premium is given in this way: we take each group of engines, no matter what they are, perhaps fifteen engines in a link, which do certain duty during the month, year in and year out, and we give an average of the amount of coal which they ought to consume; for each link and for all coal saved below the allowance the enginemmen receive 20 per cent of the value, which is considerable, as we pay 18 shillings per ton for coal delivered to our depots and the premiums received by the men on account of reduced coal consumption range from 10 shillings to 13 pounds for one year, and the extraordinary thing is, that the men who draw the largest premiums are the men who keep the best time and keep the engines in the best condition. We find this system works exceedingly well; it satisfies the men and satisfies the company, and we save a large amount of coal in that way. I think this system is much preferable to paying the lowest driver in the link £1 per month, which was the old system of working, and resulted in a heavy consumption one month to secure a low consumption the next month. When coal is so expensive at it is to us, there is every reason why we should encourage our men to be very economical with its consump-

tion, but we make a condition that the coal is not to be saved at the expense of running our trains punctually.

I am perfectly satisfied that pooling is not desirable if you can avoid it. We have almost as many engines as we require for our traffic in order to avoid pooling, but as I said before, the pooling of engines cannot be avoided where you have a large suburban traffic such as we have in London. It is absolutely necessary for us, in those cases, to pool the engines, but it does not cost us any more for repairs or for fuel in the working of that project.

**Mr. J. F. Deems**, New York Central & Hudson River Railroad. — I want to call attention to one point which may be misleading. Mr. Dugald Drummond, and others who spoken before him, stated that they were forced into the pooling system at certain seasons of the year, owing to a congestion of business or something of that kind and the results were not satisfactory. Now, I do not think it is fair to compare the results obtained under such conditions with what might be expected under a regularly organized pool. These roads are forced into pooling, temporarily, without any preparation and without the co-operation of any one, you might say, and it would be like comparing the work of the State militia, hastily called into action, with the work of regular troops. I wish to call attention to that fact, as otherwise the statements might be misleading.

**Mr. Asselin**. (In French.) — I should like to say a word in reply to Mr. Deems.

A few years ago, owing to traffic requirements, we were induced to practice pooling throughout on our lines in our goods service.

Naturally we took the greatest trouble to make the system work under the best conditions possible. Even so, the results were hardly satisfactory.

I remember that on the Northern of France, during the year 1899-1900, we practised pooling. So far as possible we arranged for supervision of the engines and the pooling system was practised under the best possible conditions. And it is upon the figures that we then obtained that we have based our views.

**Mr. A. Pilkington**, Madras Railway, India. — In Mr. Hubert's report is a statement that on the Madras Railway they adopted tentatively the pooling system and found it so unsatisfactory that they altogether discarded it. I want to explain to the meeting that on the Madras Railway we have pooled engines for shunting purposes and local train service; or, as termed in America, switching and suburban traffic. Although, for the reasons stated in Mr. Hubert's report, we have discarded the pooling system for main line working, we are under the impression that the system has its advantages, especially in countries where long sections are traversed over which there is only little through traffic and few trains are worked each day. Our engine stations are a considerable distance apart and it would not pay us to have a large number of roundhouses. We would however like to extend the running time of trains between engine changing stations to what would be beyond the capacity of single engine crews. My idea is that we might adopt what I believe

is known in America as the caboose system, carrying on board a train a certain number of coolies who could do the work of loading and unloading wagons at roadside stations, at which it would be costly to maintain a permanent staff, and relief crews for the engine, say four firemen — we always have two firemen on the footplate at one time — and two engineers. We might by that means prolong the runs for our engines very considerably and get a much better annual mileage out of them. I should be glad if some one in this room would give some information concerning a system such as that referred to; as I have said, I think it is known as the caboose system. Mr. Rhodes, in his report, makes reference to some such system of working, but I have had no opportunity of obtaining details as to how it is carried out. I think, that not only on the Madras Railway, but on many other lines, it is a system which might be worked with success.

**Mr. Busse, Danish State Railways.** — In reply to Mr. Gibbs, I want to say that the practice in regard to roundhouse stalls is to be determined by experience. In a cold climate like that of Denmark, it is quite necessary that all engines shall be put into a shed at night. Further, in our practice, when an engine goes to the workshop for large repairs, the crew is given a new engine, and as a rule, the crew never gets the previous engine again. Further, I have to say that when the reply of the Danish State Railways to question No. 6 was written, we had only a very short experience with the double crew, and in the early stages of this experience, as might be expected, we had many troubles, as is the case with almost every technical improvement. After recent experience, I should like to let you know my altered views on the question. We have now introduced double crews on a great number of passenger trains, and we save a lot of engines by it. I do not believe it augments the consumption of coal. I believe that in running, no coal is spent without a corresponding development of power, that is to say, the hauling of a greater load of the train or the making up of lost time. More lubricants may be used, but that is a trifle compared with the gain in capital which would be involved in a greater number of locomotives and in greater roundhouse accommodation. The only difficulty at present is to combine the distribution of men and engines, so as not to have too much or too little service for them, and so that the men can catch their engines at the time when they are able to go in service after a proper rest, and besides being a question of combining, it very much depends upon the working time table. It is, of course, easier to find a really economical combination when you have many trains to choose from, than where there are a few to be served by the same class of engines.

**Mr. Asselin.** (In French.) — Might I ask Mr. Gibbs one question?

On Thursday last, when we were discussing locomotives of great power, Mr. Gibbs said he was sorry that in America they had not the system of premiums for the drivers as in France. This system is obviously only possible if pooling is not usual.

The question I desire to ask is as follows : Is the tendency, at least on Mr. Gibbs' railway, in favour of decreasing or increasing pooling?

**Mr. A. W. Gibbs.** — It is rather difficult to answer that question. Mr. Rhodes stated in his paper, if I remember aright, that thirty-six roads were in favor of pooling and forty-eight roads in favor of assigned engines. I think — I do not know — from what I have read that there is a growing sentiment in favor of assigning the locomotives. I am exceedingly sorry that a representative of the Lackawanna road is not present, because that road has a system of assigned locomotives and has about seven hundred locomotives. On one division, locomotives are assigned to single crews; on the next division they are double crewed, and on the third, they are run on the multiple pool. I made a visit last year and had an opportunity of studying their system and was exceedingly impressed. I think if most of my American colleagues could see the way it was handled on that road, that the favor in which the pooling system is held would be increased. I think Mr. Asselin is slightly mistaken in regard to my stating a regret that the men did not receive bonuses on the locomotives of great power. In explaining to my American colleagues I was simply giving the results of the observations of a locomotive engineer whom I sent to France, and among other railroads, he spent considerable time on the Northern Railway of France, and he made a report to me giving the system of premiums for coal saved, time made up, time kept out of shop, and penalties for the time lost and excess of coal used. If that could be worked satisfactorily in this country and produce the results which were given on the Northern Railway of France, I should be very glad to see it done. I am merely quoting from a report of our own engineer.

**The President.** (In French.) — We should find it very difficult to finish this debate at a single sitting. It is getting late and so I propose that we adjourn till 2 o'clock. We can then finish the debate and arrange the conclusions upon this very interesting subject. (*Agreed.*)

— The meeting adjourned at 12.10.

---

**Meeting held on May 9, 1905 (afternoon).**

---

**The President.** (In French.) — We will now continue the debate commenced this morning.

I beg to call upon Mr. Hoy.

**Mr. W. W. Hoy,** Central South Africa Government Railways. — I do not rise to take part in the discussion, but only to give some information requested by one of the delegates in regard to the caboose system. The caboose system has been in use on the Rhodesia Railway since 1897. There is accommodation in the caboose for two drivers, two firemen and two guards. The shifts are twelve hours, and the run is 1,000 miles from Mafeking to Bulawayo, being a continuous run of 500 miles, with

a rest of ten hours at the end of that run, and the return from Bulawayo to Mafeking, being 500 miles, where eighteen hours rest is given. The men employed in that service receive a small allowance per diem for travelling in the caboose. The system at first was received with some opposition, but is now entirely successful. I was upon that line for a year and a half, and I speak for the period of my service. As far as I know, the system is still in operation and quite successful. The number of cars in a train for one of the large engines is thirty vehicles. The pooling of crews has been practised in South Africa and it was most successful — it was in operation partially during the period of the war, which is not a fair comparison of conditions or a fair period to take. Engines were pooled throughout that period, but it is not a fair comparison, and for that reason I do not propose to offer any observations on the subject. If there is any other information I can give you in regard to the caboose system I shall be glad to do so. One of the drivers takes service for the first twelve hours and the second driver takes service for the second twelve hours of the day. The first driver goes on again at the end of half of the journey, at Bulawayo, the termination of the first 500 miles. The engine at that point is banked for ten hours and the staff during that period takes a rest.

**Mr. W. McIntosh, Central Railroad of New Jersey.** — The object of pooling engines is naturally to obtain economy in operation. Where this can be secured, pooling has been considered a success. It is difficult, I imagine, to establish a pooling arrangement over any large system, for the reason that there are so many varied conditions. There are, however, on most systems divisions or districts where pooling is almost necessary, and when a pooling system is properly organized good results are obtained. Where the service is of such a nature that the engines can be utilized, and you can make more mileage than the crews can work, you must either pool your engines in a systematic manner or accomplish the result in an unsystematic way by having relief crews at hand to relieve the regular ones when they become fatigued. In my experience of handling crews under such circumstances, I have found that there is a tendency for the regular crew to either ask relief from service at times when they were not justified in doing so, or to remain in service a considerably longer period than they were justified in doing, and in the latter instance, more or less, to the disadvantage of the service. The unpopularity of pooling engines may be first ascribed to the fact that there is more attention required in the way of supervision than there is with the regular engine system and also to the prejudice of the enginemen who are naturally opposed to changing their engines. Another factor which enters largely into the making of pooling unpopular is the lack of facilities for doing the repair work promptly and thoroughly, or the neglect to maintain the system in proper form when once established. It is not difficult to formulate a system of pooling and to establish it, but it is a difficult matter to maintain a system of pooling in satisfactory operation, and that is where the success or failure lies either in the proper maintaining or the failure to do so.

To pool locomotives successfully, and in fact to maintain them successfully, in these days of large power and severe requirements, can only be done by the shop force — the engineman's assistance is a small factor and will consist merely in stating what is wrong, making an intelligent report at the terminal as to what he has discovered wrong with the engine and what is required to repair it. The balance of the work must be done at the terminal and by the terminal force, and on the thoroughness of inspection and repairs depend the results. There are abnormal conditions in some of the Western States where there is exceedingly bad water, boiler feed water I mean, when engines are held off for each trip long enough to wash out the boilers and refill them. Under such conditions, it is possible to follow the engines with regular crews, but in most instances where large power is used and the service is exacting, it is an utter impossibility for regular crews to attempt to follow their engines.

On the system I am connected with, we operate some districts with single crews, some with double crews, and other districts we pool entirely. In our heavier service, that is, moving anthracite coal from the mines to tidewater, we pool the engines exclusively. That is our heaviest equipment and we cannot conceive that in any other manner could we possibly secure the results in the way of service that we now obtain.

**The President.** — Is Mr. A. H. Smith present? If not, does any one else wish to speak upon this subject?

**Mr. H. J. Small,** Southern Pacific Company, United States. — Just before the morning's session adjourned, a question was asked by one of the foreign delegates as to the present status of pooling in this country. I think Mr. McIntosh has partially answered that, but I do not think his remarks were a direct answer to that question. I believe that I can speak for the far west in particular, and for other parts of the country generally. All over this country there has been a marked change recently respecting pooling, possibly since Mr. Rhodes' report was written. On the system I am connected with, the company has in the past few years changed from coal to fuel oil very largely; probably 80 per cent of our power is now using fuel oil. We very emphatically discovered the evil effects of pooling especially in bad water districts. The number of engine failures increased very largely. The result was that we were obliged, almost, to single-crew all engines, with the result that engine failures decreased very rapidly, and I think they are now down to their minimum. I believe it is safe to state that the sentiment in regard to pooling engines in this country is changing. I think in a short time it will be found more economical to single-crew engines. Of course, there are times on all lines when there is a rush business, when pooling is necessary for a short time only. When the dull time came again it gave an opportunity to get the engines up into condition; but I think the result almost everywhere has been that where pooling has been practised, the efficiency and condition of the power has very considerably decreased.

**Mr. A. Lovell**, Atchison, Topeka & Santa Fe Railway, United States. — I wish to endorse what Mr. Small has just said in regard to the changing sentiment in regard to pooling engines, which corresponds with our experience on the Santa Fe road. When I went to that system about two and half years ago, nearly all the divisions on that system had pooled engines to a certain degree, most of them being in the freight service. The passenger service was operated mainly by double crews, or three crews to two engines. Within the last year or two, particularly on the westerly end of the system, where crude oil is used for fuel, our experience has coincided with that of Mr. Small on the Southern Pacific — the engine failures increased very rapidly. The engineers and firemen failed to have the interest in their engines that was desirable, and all the efforts of the master mechanic and every one else connected with the motive power department, failed to keep up the interest that was desirable on the part of the engineers in taking care of the little details necessary to prevent engine failures on the road. During the past year, we have been endeavoring to get engine crews assigned to the engines as far as possible, and at the present time this has been accomplished to a greater or less degree on nearly every division of the system from Chicago to Los Angeles and San Francisco. About the last part of the territory which went into the assigned system was the Arizona division and that was one of the divisions which previously caused the greatest trouble on account of failures. The crews were assigned to the engines in this territory I think in December last, and the engine failures immediately began to decrease. The condition of the engines began to improve, and in March our reports of engine failures showed they were less in that month than in any month for three and one half years. We attribute the improvement very largely to the assignment of crews to the engines. It has occurred to us that it is better to lose a little time with the engines in the roundhouse and keep them in satisfactory condition for service, so that when they go out they will take the train to the next terminal, rather than to rush them out of the roundhouse on to a train and have them fall down after they get half way over the division. There is not as much time lost in taking care of them before they go out as there is in taking care of them on the road if the engines fail. We have very large engines and we have considerable trouble with the water, that is, water which has bad effects on the flues and fire-boxes, causing a good deal of leaking and a good deal of sediment in the water; and for this reason it is usually necessary to hold an engine in for washing out the boilers, calking the flues, etc., for at least six or eight hours on each round trip. On some of the divisions, the runs are 150 miles in each direction. Where that is the case, the engine crews can get the necessary rest while the engines are being cared for, and no more engines are required than would be if we had the pooling system in use. It is found to be much more satisfactory under these conditions to have the engines assigned. These conditions do not prevail on all the divisions of our system. There are places where it is necessary to pool the engines to a certain extent. Usually, where they are assigned, we have a certain number of engines on certain

kinds of service that can be drawn upon to put into the regular service in case one is taken out for repairs, and we also have a certain number of extra men and extra engines that are not in the regular assignment. This is found to work out very satisfactorily in case an engineer lays off or his engine is required to be put in the shop.

**The President.** — Has any one else anything to say on this subject before the conclusions are presented to the meeting?

**Mr. T. Ronayne,** New Zealand Government Railways. — I desire to make a few remarks which may be of interest to the delegates with regard to item No. 1, that is the assignment of special crews to special locomotives. Our experience in New Zealand leads us to believe there is no question but that it is the most satisfactory system. We find that the crews take a very great interest in their machines, in fact they spend considerable time in getting them prepared for the road, and they look upon them as part and parcel of themselves, practically their own property. That is the condition of affairs with regard to the assignment of special engines to special enginemmen.

We have found double crews are also satisfactory under certain conditions and the conditions are these — that is, you have an opportunity to make a better selection of the men. If you have a proper selection of men, men who work harmoniously together for the common good, the system is very satisfactory indeed. The multiple crew system is resorted to as little as possible. Three crews are largely used and with selected men have been found unobjectionable. We have a large number of trains running in from distant parts of the country into the centres, and with three men crews there is no difficulty whatever in dividing time, no trouble whatever with the three men crews; but in the case of the double crews we have to select our men and see that they work harmoniously and are suitable. Interpolated crews are not much in vogue and are considered objectionable. Pooling is resorted to only when the locomotives in service are unable to cope with the business. I might mention that these remarks do not apply to the shunting. The shunting locomotives are invariably pooled. But where the shunting is very extensive there is generally a foreman in charge of the locomotive depot who has these particular engines under his notice, and the results are not unsatisfactory.

Where we have had to resort to pooling, serious accidents have sometimes happened, traceable to the system. It has been found that enginemmen who work on the pooling system do not take the interest in their work which is so apparent in the single crew system. Additional fuel and lubricants are used and repairs are also much increased; disputes also arise as to the consumption of fuel and lubricants. I might quote a case which came under my personal experience just before I left my country, and that was the dropping of a fusible plug. The plug was dropped and the engineman who was on the engine at the time said it was due to the carelessness of the man who ran the engine the day before, but after considera-

tion, we concluded that it was due to the carelessness of the man who had the engine, that it never would have dropped if he had looked over his engine properly, and he was obliged to pay a fine of 30 shillings. With the fusible plugs we rarely have damage to our boxes, but in this case the fire was put out and the traffic on the road delayed, but that was the only trouble which resulted. In transferring from engine to engine in the case of pooling, I might say that the list of tools is pasted on each engine. The placard is varnished, and is put under glass so that it cannot be changed. The equipment of each engine is printed on that notice and a frequent inspection of the tool box is made by the foreman. The tool boxes are supplied with spare motion pins and other parts which may become useful in a break down. We found it a wise provision in various cases in the event of a pin working out of the Walschaerts gear, as we could take the engine forward by putting in an old pin which would be sufficient to carry it to the depot where a new pin could be procured.

**Mr. Nolte**, Moscow-Kazan Railway. — In order to show how different the conditions for pooling are, I may mention that we consider crude oil the most economical fuel for pooling engines. With us, the cost of fuel consumed in an ordinary engine is about \$345 per month, while the wages of engineers and stokers amount to \$85 for the same time. This being the average ratio, it is evident that the slightest increase in the consumption of fuel would be absolutely ruinous. It has been observed in the discussion that fuel spent meant power developed, but we know that fuel in the shape of steam is often wasted and much more so when the pooling system is in force. That is the reason why we try to avoid pooling as much as possible with the exception of switching and suburban traffic. Nevertheless we are often obliged to resort to pooling, especially when traffic is exceptionally intense. We also practice the caboose system for ballast trains with very good results. With our kind of fuel, pooling proved to be very ruinous, and locomotive failures occurred very often.

**The President.** — Does any one else wish to speak?

**Mr. Flobert.** (In French.) — On the Northern of Spain we have employed multiple crews and we are still using double crews occasionally but solely because we are obliged to do so. Otherwise we should go back to the single crew system which has always seemed to us the best.

**The President.** — I will ask Mr. Gibbs if he will kindly repeat what he has said to me in conversation about the continuation of pooling, even with the large number of locomotives being put out of service.

**Mr. A. W. Gibbs.** — The point I mentioned to the President was in answer to the question — what is done when there is a great fluctuation of business in the pooling system; what to do with the locomotives when the business is not sufficient to keep them employed. Our practice is that when there is not sufficient business to keep the locomotives fully employed, all locomotives which can be spared should be

tallowed and laid aside in good condition, because the fewer number of engines will mean fewer number of roundhouse operations. We believe the roundhouse cost of keeping a few engines very busy is much less than keeping a large number of engines partially busy. If an engine stays in the shop or roundhouse every day, doing nothing, you will still find cost in connection with that engine going on. In almost any system of charging accounts you will find that there are charges against the idle engine; and while I do not know that we will all agree on the subject it is my belief that the proper way to provide for diminution of business is to lay aside every engine that can possibly be spared, choosing the engines which are in good condition so that when expansion again occurs you can get good locomotives. On our road we have had three hundred locomotives tallowed at a time and laid away. I think the same thing holds true to some extent with other roads in this country where the engines are assigned to single crews, but the engines are tallowed and the crews put back firing or put on the extra list. I do not think this practice of laying engines by is confined to the pooling system alone.

**The President.** — If no one has anything more to say on this subject, the discussion may be considered as closed. I suggest that we suspend the meeting in order that the conclusions to be presented to the general meeting may be drawn up by our Secretary. (*Agreed.*)

— The meeting adjourned at 3 p. m. and met again at 3.10.

**The President.** (In French.) — I will now ask Mr. Boell to read the conclusions which our officers submit for the section's approval.

**Mr. Boell,** *principal secretary and reporter :*

“ The section finds that in Europe and in countries other than North America the general sentiment is very much in favor of the single crew system and unfavorable to complete pooling, which is only used when necessitated by a sudden increase in traffic. However, for certain services various combinations of double or multiple crews or of mixed crews are used according to circumstances.

“ In North America pooling is, on the contrary, very general, though little used for passenger service, and a tendency to using single crews is generally manifest.

“ It should, however, be remarked that the organization of train service depends to a large extent on local conditions. ”

**The President.** — Has any one any amendment or alteration to suggest to these conclusions?

— The conclusions were unanimously adopted.

— The meeting adjourned at 3.15 p. m.

---

## DISCUSSION AT THE GENERAL MEETING

---

Meeting held on May 11, 1905 (afternoon).

---

MR. STUYVESANT FISH, PRESIDENT, IN THE CHAIR.

GENERAL SECRETARY, MR. L. WEISSENBRUCH.

ASSOCIATE GENERAL SECRETARY, MR. W. F. ALLEN.

Mr. Ed. Sauvage, *president of the 2<sup>nd</sup> section*, read the

### Report of the 2<sup>nd</sup> section.

(See the *Daily Journal of the session*, No. 7, p. 136.)

“ Mr. BOELL summed up his report, and read the following conclusions :

“ 1° The pooling system always leads to a very perceptible increase in the expense per kilometre, and therefore it ought not to be employed except in case of absolute necessity.

“ 2° For the purpose of increasing the work of engines, it is preferable to have recourse to the system of auxiliary crews, or to the multiple crew system, the evils of which are infinitely less.

“ 3° The double crew system is particularly to be approved, particularly for switching, suburban or shuttle train service, and even for certain classes of through train service, for the reason that, while affording better utilization of engines than the single crew system, it may permit of a slight saving in fuel without appreciable increase in cost of repairs.

“ 4° With these various systems, it may be of advantage in fuel expense to assign to each engineman a particular tender which, however, gives rise to certain complications in the service and cannot always be realized.

“ 5° The system of three men crews may in certain cases be substituted advantageously for that of double crews.

“ 6° Finally, other systems than that of the single crew have little to commend

them for fast express train service, which demands engines in a perfect condition of repair and well understood by the engineman who handles them.

“ Mr. HODEIGE (*Belgian State Railways*) gave an abstract of the report presented by the lamented Mr. E. Hubert, recently deceased. It appears from this report, that out of fifty roads which have replied to the questions of the reporter, sixteen use single crews only, except in switching operations at the yards, where some of them use double crews and that twenty-four roads, representing about 48 per cent of the total mileage, prefer without exception the use of single crews. After the single crew, the system most used is the double crew. A great majority of railroads which regularly use this system, recognize that the advantages which it affords, in the annual number of kilometres run by their locomotives, in the reduction and regulation of the number of working hours of the employés and in lighting up and banking, are only obtained at the expense of increasing the consumption of fuel and lubricating materials and also at the cost of a poorer maintenance of the engines.

“ The three men and multiple crews are not used except for yard switching operations or under special conditions. Finally, complete pooling is little in favor, and outside of the Taff Vale Railway (England), which seems to be pleased with it, and the Transbaikal (Russia), which operates under peculiar conditions, this system is not used if it can be avoided. The reporter is of the opinion that this system cannot be well judged, except after studying the results obtained by important companies using it on their systems, in a permanent and general manner.

“ The principal secretary Mr. BOELL then summed up the report of Mr. G. W. Rhodes.

“ It appears from this report that out of eighty-four replies obtained forty-eight were against and thirty-six in favor of the complete pooling system.

“ The reporter stated that two important points controlled this matter thirty years ago and still exert the same influence today :

“ 1° The complete pooling system increases the cost of transportation.

“ 2° The main advantage of the complete pooling system, which is of a nature to compensate for the increase in expenses, is the possibility of doing the work with fewer locomotives which effects a reduction of the capital investment.

“ The reporter arrives at the conclusion that the essentials for a properly conducted engine pool are as follows :

“ 1° An engine house inspector, or inspectors, whose duty shall be to report all work on incoming engines, which shall be checked up with the engineman's incoming report. Provision should be made to have all work properly attended to; neglect in this matter has done more to injure and discredit pooling than any other feature. Men in a pool, who when they have, on leaving work, reported a defect, and ten days later get on the same engine and find the same thing which

requires repair still not attended to, drop into careless habits. If a regular man had the engine he would raise objections until the work as reported was done. In a pool the foreman or workman has a chance of saying : ' Another man will get this engine who will not know whether this work was reported or not. '

" 2° A sufficient engine house force to attend all cleaning of engines both below and above the footboard and in the cab. Provision to be made also for cleaning and filling all engine lights.

" 3° All lanterns to be maintained and kept under a tool room check system. Under this system, lanterns are pooled in the same way that engines are, and each incoming engine crew has to account for its lanterns. The number of lanterns under this system is materially minimized through a large proportion of these being in constant service.

" 4° Heavy engine tools to be kept in a sealed box on the engine, the seal to be carefully inspected on each arrival. Each engineman to be supplied with a portable tool box.

" 5° A kit of oil cans should be assigned to each driver and returned by him after each trip and placed in the oil room to be properly filled, cleaned and cared for.

" 6° A set of enginemen's lockers or boxes should be at the disposal of the engine crew.

" The report concluded with the statement that no hard and fast rule can be made that will fit all railroads in the matter of pooling engines; the conditions of traffic, together with the amount of equipment as existing on each road, alone can determine the expediency for or against pooling.

" Mr. Alfred W. GIBBS (*Pennsylvania Railroad*) began the discussion by stating that the pooling system has been generally used on his lines for the last twenty-eight years, except for some passenger trains which have single or double crews. The roundhouses are organized for this system, and do not afford, on an average, more covered space than is required for four engines. He would be pleased to know how the single crew system is organized in Europe — that is, who takes care of the engines while the employees in charge are resting, how the crews of the engines in repair are utilized, and how the engines repaired are distributed.

" Mr. TORDEUX (*French Eastern Railway*) reported on the poor results obtained on his system by the use of a double crew. The number of accidents caused were so great that it finally required the service of a greater number of engines to straighten out these accidents.

" Mr. ASSELIN (*French Northern Railway*) replied to Mr. Alfred W. Gibbs that engines are inspected on arrival at the roundhouse by the machinist and the station masters, and that special firemen take care of them. When an engine goes into the shop, a supplementary engine is turned over to its crew until the latter can again

take up the engine, which is regularly assigned to it. On the average, the number of covered places available at the roundhouse is equal to half of the engines belonging to it.

“ Replying to a question by Mr. Asselin, Mr. Alfred W. GIBBS stated that the longest continuous run ever made by a locomotive in America was, to his knowledge, 284 miles on a freight train with a double crew.

“ Mr. SABOURET (*French Western Railway*) stated that the great difference which exists between American and European practice can be explained by the difference in the cost of fuel, which costs from 1 to 2 dollars on the tender in America and 3 to 4 dollars in France. In France, the consumption of fuel represents an expense double that of the wages of the engine crew; it would be interesting to know what this proportion is in America.

“ Mr. A. E. MITCHELL (*Lehigh Valley Railroad*) stated that for modern locomotives the cost of fuel on his system exceeds the wages of the employees by 10 per cent and that on other systems this expense is practically the same.

“ Mr. Dugald DRUMMOND (*London & South Western Railway*) reported that pooling is unusual in his country, except for certain suburban traffic; the maintenance and fuel consumption of the pooled engines being 10 per cent higher than that of the single crew. Money prizes encourage the drivers to be economical with fuel and to take care of the engines.

“ Mr. J. F. DEEMS (*New York Central & Hudson River Railroad*) remarked that pooling would give better results when practised in a general and continuous way than when used only at certain times to suit the requirements of the traffic.

“ Mr. ASSELIN replied that in spite of all precautions taken by the Northern Railroad when it tried to introduce pooling, the results attained were entirely unsatisfactory.

“ Mr. Arthur PILKINGTON (*Madras Railway, India*) explained that his road, having stations great distances apart, would very much like to find a system which would enable it to run its locomotives much greater distances than can be accomplished by its crews. He would be pleased to get some information on the working of the ‘caboose’ system, which consists in taking along on the train a second engine crew.

“ Mr. O. F. A. BUSSE (*Danish State Railways*) reported that in a country with severe climate, all engines must be provided with shelter and that on his road, if an engine enters for repair, the crew in charge of it takes another engine. On his road, the double crew is used on many passenger trains, which enables them to reduce the number of necessary engines without noticeably increasing the expenses. The cost of lubrication alone increases, but this increase in expense is small if the economy

realized on the capital is considered. The only difficulty is in the division of the labor of the engines and the crews, and this difficulty varies with the service to be performed.

“ Mr. ASSELIN stated that, at a previous meeting, Mr. Alfred W. Gibbs had expressed his regrets that the engine crew in America does not get money prizes for economy, as in France. The system of prizes is not practicable with pooling, and he asked Mr. Gibbs whether the tendency in America is to increase or reduce pooling.

“ Mr. Alfred W. GIBBS replied that, at the present time, the sentiment in America seems to be favorable to putting locomotives in charge of certain crews, as shown by the example of several roads. In expressing his regrets that there are no money prizes in America, he repeated the opinion of an engineer sent by him to France. If he were sure to obtain the same results by applying the same system, he would be well pleased to do so.

“ Mr. W. W. HOY (*Central South Africa Government Railway*) supplied some information on the working of the ‘caboose system’ on his lines, which consists in employing two complete crews and shifting them after twelve successive hours’ run, and giving them a complete rest of ten hours after a run of about 500 miles.

“ Mr. William McINTOSH (*Central Railroad of New Jersey*) stated that he was of the opinion that pooling is the most suitable system for the operation of a great railroad system with heavy traffic, but it is difficult to organize and requires closer attention to the inspection service, which renders the system unpopular. Certain sections of his road are served by single crews, others by double crews, but on the most busy sections pooling dominates absolutely, and the nature of the traffic does not permit of the use of any other organization.

“ Mr. H. J. SMALL (*Southern Pacific Railway*) reported that the use of crude petroleum as a fuel for several years past has increased the difficulties of pooling to such an extent that his company had to go back to the single crew system, with the result of a considerable reduction in the number of accidents.

“ Mr. A. LOVELL (*Atchison, Topeka & Santa Fe Railway*) confirmed the statement of Mr. Small. For the same reason his company had to return to the single crew system, as engines using liquid fuel cannot be conveniently maintained if they do not stay at the roundhouse a sufficiently long time. Moreover, the bad quality of the water compels them to wash the boilers after a run of six to eight hours. He added that these conditions are not the same throughout the whole country.

“ Mr. Thomas RONAYNE (*New Zealand Government Railways*) maintained that the single crew system gives more satisfactory results because the men take better care of the engines. The double crew gives equally good results if its crews are suitably selected. The three-men crew is much used on his system under the same condi-

tions. The multiple crew and the system of mixed crews are little used, and complete pooling, which has given poor results in all points, is employed as little as possible except for station operations.

“ MESSRS. G. NOLTEIN (*Moscow-Kazan Railway*) and FLOBERT (*Northern of Spain Railway*) declared themselves also opposed to the complete pooling system.

“ Mr. Alfred W. GIBBS supplied some information on the measures taken by the Pennsylvania Railroad as a consequence of traffic fluctuations. It is, of course, understood that the system needs a sufficient number of engines to enable it to handle the greatest requirements of its traffic; when the traffic decreases, all locomotives which are not necessary are put aside and carefully oiled to avoid unnecessary maintenance expenses. As to the employees who cannot be utilized, they are laid off temporarily.

“ The section finally adopted the following draft of conclusions for submission to the general meeting. ”

**The President.** — The following are the

#### CONCLUSIONS.

“ The Congress finds that in Europe and in countries other than North America the general sentiment is very much in favor of the single crew system and unfavorable to complete pooling, which is only used when necessitated by a sudden increase in traffic. However, for certain services various combinations of double or multiple crews or of mixed crews are used according to circumstances.

“ In North America pooling is, on the contrary, very general, though little used for passenger service, and a tendency to using single crews is generally manifest.

“ It should, however, be remarked that the organization of train service depends to a large extent on local conditions. ”

— These conclusions were adopted by the general meeting.

# APPENDIX

## Corrigenda to the report No. 3, by E. Hubert.

Page 683 of the *Bulletin* of February, 1905 (page VI-33 of the separate issue No. 30 and of the *Proceedings*), lines 14 and 15 from the bottom, *omit the words* : " Western Australia Government Railways ".

Page 685 of the *Bulletin* (page VI-35), line 13 from the top, *instead of* :

" 2,187 - (1,350)	Western Australia Government Railways . . . .	291	176	7,253,242 (4,507,019)	11,211,612 (6,968,662)
----------------------	---	-----	-----	--------------------------	---------------------------

*read* :

" 2,480 (1,541)	Western Australian Government Railways . . . .	329	234	7,393,569 (4,594,234)	9,193,947 (5,712,957) "
--------------------	--	-----	-----	--------------------------	----------------------------

Page 693 of the *Bulletin* (page VI-43), between lines 10 and 11 from the bottom, *interpolate* the following paragraph :

" WESTERN AUSTRALIAN GOVERNMENT RAILWAYS. — Pooling was introduced in this State on the main line to the Kalgoorlie Goldfields in July 1904, and is giving most satisfactory results. "

2<sup>nd</sup> SECTION. — LOCOMOTIVE AND ROLLING STOCK.

---

[ 628 .216 ]

QUESTION VII.

---

AUTOMATIC COUPLERS

---

*Advantages and disadvantages of automatic couplers.*

*Improvements effected in their construction. Their use in conjunction with other couplings.*

**Reporters :**

**America.** — Mr. A. W. GIBBS, general superintendent of motive power, Pennsylvania Railroad.

**England.** — Mr. W. F. PETTIGREW, locomotive, carriage and wagon superintendent, Furness Railway.

**Other countries.** — Mr. G. NOLTEIN, membre du conseil d'administration du chemin de fer de Moscou-Kazan.

---

## QUESTION VII.

---

## CONTENTS

---

	Pages.
Sectional discussion . . . . .	1263
Sectional report . . . . .	1298
Discussion at the general meeting. . . . .	1298
Conclusions . . . . .	1308
Appendix I : Addenda to report No. 1, by W. F. PETTIGREW. . . . .	1309
— II : Note on the Boirault automatic car coupler . . . . .	1317

### PRELIMINARY DOCUMENTS.

Report No. 1 (England), by W. F. PETTIGREW. (See the *Bulletin* of July, 1904, p. 547.)

Report No. 2 (all countries, except England and America), by G. NOLTEIN. (See the *Bulletin* of January, 1905, p. 173.)

Report No. 3 (America), by A. W. GIBBS. (See the *Bulletin* of January, 1905, p. 287.)

Vide also the separate issues (in red cover) Nos. 1 and 24.

---

## SECTIONAL DISCUSSION

---

Meeting held on May 10, 1905 (morning).

---

MR. ED. SAUVAGE, PRESIDENT, IN THE CHAIR.

**The President.** (In French.)— In the absence of Mr. Pettigrew, I call upon Mr. Gibbs to open the discussion with a summary of his paper.

**Mr. A. W. Gibbs, reporter for America.** — I am going to ask permission of the meeting to omit the reading of my report, for the reason that it is largely a historical statement of what has been done. It is not a statement of problems which have to be solved, because in this country, the automatic coupler is an accomplished fact. Its form has been settled by the mechanical people and it has been endorsed legally, so that the only problems with us are those of securing an uniformity in the requirements, sufficient strength and some of the minor problems such as the provision for coupling on severe curves. It may be said that the latter is about the only serious problem that has to be settled, as since the introduction of steel, the strength of the couplers in tension, at any rate, is far beyond that of any two engines which we can put on the train.

Since my report was written, I have had tensile tests made of a large number of the couplers of the different makes and I find that the weakest, of practically an obsolete type, had a strength as high as 104,000 pounds. I find that the modern steel couplers have a strength which ranges anywhere from 200,000 to 291,000 pounds, and in fact we tested a number which did not break at 300,000 pounds, so that structurally I do not feel we have to do more than enforce existing specifications.

The other countries have the problem to face of what they will do — whether they will introduce automatic couplers at all, the type of automatic couplers they will use, and whether they can attach these couplers to the existing vehicles without costs which would be prohibitive, so that I think greater results will be obtained by all here from discussing the papers of Messrs. Pettigrew and Nolte, which deal with a problem which is not solved. With your permission, therefore, I will omit the reading of my paper.

**The President.** (In French.) — Will our secretary kindly read us the conclusions of Mr. Pettigrew's report.

**Mr. Paul-Dubois, secretary.** (In French.) — In his report, Mr. Pettigrew accepts the conclusions of the report of a Royal Commission appointed in England to consider couplings. These conclusions are as follows :

The greatest number of accidents appears to arise from the dealing with wagons in motion, when engaged in goods and mineral traffic. The wagons have to be arranged and marshalled chiefly in shunting yards and sidings. Nearly one-half of the wagons belong to private owners, in whose trade they are employed.

In order to effect the necessary operations, trains have to be dissected, wagons separated one from another, and then placed together again so as to constitute a full train.

This involves the coupling and uncoupling of many wagons, frequently when in motion. Operations have often to be carried on at night, in yards not always sufficiently lighted and under conditions as to space, which render it difficult for the men duly to do their work.

Until some twenty years ago, the coupling and uncoupling of wagons on railways, were performed by men who had to pass between the wagons for the purpose, but a practice was then introduced of coupling and uncoupling by means of a pole, and such practice came into almost universal use about the year 1886. No doubt the use of the pole has lessened the risks incurred by railway servants, but it by no means represents a perfect method of couplings and uncoupling, and gives rise to considerable and regrettable risk to the men employed.

In order to make use of it, men who in the night time have to carry a lamp in one hand, are necessarily obliged to run by the side of a moving train and find a fulcrum as best they can on which to rest the pole. The space in which the pole has to be used is often of a too restricted character. Under these circumstances, if a man over-reaches himself, or slips, or catches his foot in any impediment, he is liable to sustain injuries of a very serious character.

It has to be observed that the shunting pole can only be used with loose link couplings, but as a number of wagons in use on railways are fitted with stiff couplings, it is necessary for the men when coupling and uncoupling, to pass between them and use their hands for the purpose of doing this work.

**Mr. Pettigrew then adds :**

I cannot do better than conclude with these extracts from this most excellent report of the Royal Commission, but I cannot find that the recommendation of the two last paragraphs above have been carried out either by the railway companies, or that powers have been given to the Board of Trade, to appoint a committee to co-operate with the railway companies.

**Mr. Noltein, reporter for all countries except England and America.** — Automatic couplers have been adopted in Europe with two objects, first to avoid the frequent accidents which occur during shunting and secondly, to increase considerably the strength of the couplings.

The only solution of this double problem is that which has been obtained in the United States through the use of the couplers well known as the M. C. B. (Master Car Builders Association Couplers). These couplers are fully interchangeable and, according to Mr. Gibb's report, afford great security to the men employed in shunting.

Unfortunately the use of this very ingenious apparatus involves a very considerable increase in dead weight, and the smaller the capacity of the cars, the greater becomes this disadvantage. In the case of the ordinary European goods trucks, with a capacity of from 10 to 15 tons, the increase in dead weight due to using an automatic coupler amounts to about 1,785 lb., with a corresponding increased expenditure, and yet we get no equivalent return in the matter of safety till after a long transition period.

This fact in itself is sufficient to explain why many European engineers are convinced that the adoption of M. C. B. couplers in addition to the existing couplings would prove absolutely ruinous to the railway companies.

The solution of this double problem cannot be obtained by strengthening the European couplings (as experience has proved); it must, therefore, be sought in an application of the American system, capable of giving the desired result, to the most complete extent.

As German and Russian lines are the ones which, owing to sundry economic conditions in those countries, are compelled to look forward to reductions in the rates, it is quite natural that the first experiments should be made in those countries.

The following programme was submitted to the different managements of the railways belonging to the *Verein* as a guide in carrying out these trials :

1° The shape of the coupler head must approximate as closely as possible to the standard pattern recommended by the American Master Car Builder's Association;

2° The distance between the centre of the head and that of the drawhook shall be 240 millimetres ( $9\frac{7}{16}$  inches);

3° The centre of the surface of contact of the head (of the knuckle) shall project 15 millimetres ( $\frac{19}{32}$  inch) beyond the faces of the side buffers (buffers not compressed);

4° The travel of the spring of the automatic coupler shall amount to from 50 to 100 millimetres (2 to 4 inches);

5° The lateral play of the coupler head shall not amount to more than 75 millimetres ( $2\frac{31}{32}$  inches) on either side.

The Moscow-Kazan Railway (Russia), having recognised the urgent necessity of strengthening the drawgear so as to increase the paying load of their trains gradually to 1,000 tons, proceeded to the investigation of the subject in 1898.

The principles adopted by this railway in the construction of transition appliances, differed, however, from those of the German *Verein*, although the same object was aimed at. These principles were :

1° The transition must be effected in one single period; and consequently, the American coupler head must be fitted in its definite final position;

2° The centre of the coupling must be in the same horizontal plane as the centre of the underframe;

3° In order to avoid possible and even very probable errors which might result if

a new shape of coupler head were adopted, the shape must be exactly that specified in the rules approved by the American Car Builders' Association (the M. C. B. type);

4° The travel of the coupler head, which in America is fixed at 35 millimetres ( $1 \frac{3}{8}$  inch), must be increased to from 60 to 65 millimetres ( $2 \frac{3}{8}$  to  $2 \frac{9}{16}$  inches), in order to increase the elastic work of the drawsprings which also act as buffer springs;

5° As the substitution of American automatic couplers in place of the old screw couplings gives rise to considerable expense, it is absolutely necessary that the lines which adopt this alteration should from the beginning gain some advantage from it.

The arrangement recommended by me has been fitted to some 27 ton trucks, and this is the only pattern of trucks now being built for the Moscow-Kazan line.

Another solution has been suggested for passenger carriages.

In the case of couplings for passenger carriages, the question appears to the reporter to be very different; on the one hand, as there are fewer vehicles and they are generally used in made-up trains requiring no complicated shunting operations, the change can be effected with much less difficulty; on the other hand, the existing couplings are so poor and so unsuitable for passenger carriages, that their use on modern rolling stock seems to be a grotesque anachronism.

Screw couplings, in addition to their well-known disadvantages as far as the safety of the employees is concerned, are in no way adapted to satisfy the special conditions which prevail in the case of the passenger train service. This service is run at high, or at least at considerable speed, with short stops at stations, which allow but little time for adding or detaching carriages or for joining up sections coming from different directions.

The principal disadvantages of the existing coupling under these circumstances are as follows :

1° It is well-known that if the couplings are screwed up tight, so that the buffer springs are compressed to a certain extent, this much assists the smooth running of the carriages, as the friction between the faces of the buffers opposes oscillations of all kinds as well as sideway movements.

But this method of obtaining smooth running, only attains the desired object in a primitive and incomplete manner ;

2° A condition which is essential for the safety of the passengers in case of accidents, is to prevent as much as possible, the vertical displacement of each carriage relatively to the adjoining carriages.

It is, however, quite evident that the present coupling in no way interferes with the relative movements of the ends of two wagons in contact.

As for the buffers, these appear to be devices specially designed to guide the underframes into the bodies of the wagons behind, and in this way to render every accident more disastrous. For as the axes of the rods of two buffers in contact are

hardly ever in the same straight line, the rods are easily bent, and thus in case of a collision, they form inclined planes which force each underframe on to or under the adjoining one, and thus they contribute to the destruction of the bodies;

3° When much space is left between the carriages, the gaps have to be bridged over with long and inconvenient footways protected by railings. If vestibules are provided, the latter are also long and costly and subject to considerable wear, as they have to follow all the relative movements of the carriages;

4° The drawsprings as well as the springs of the lateral buffers being comparatively very compressible, the wagons of a train form masses which are capable of considerable relative movement in the direction of the length of the train.

All these disadvantages have long been recognized by the engineers of the European and American railways.

But whereas the obstacles which the European coupling puts in the way of the solution of these problems are almost insurmountable, the automatic coupling enables American engineers to solve them in a simple and neat way by the arrangement known as the " Platform Equipment ".

The following, then, are my conclusions :

1° In the case of passenger carriages, the question of the application of American couplers seems to be easier to solve, as their number is much smaller than that of goods wagons, and the service is much more regular;

2° The transition systems examined for goods wagons are equally suitable for carriages. But any arrangement with considerable overhang is not to be recommended, for the reasons explained in the report;

3° In the case of new carriages, equipment with spring vestibules offers essential advantages from the point of view of safety. It makes the carriages run more smoothly, it counteracts any shocks due to badly adjusted continuous brakes and offers certain guarantees in case of accident.

**The President.** (In French.) — One matter of the very greatest importance with regard to these couplings, concerns the difficulties that may arise during the period of transition from one system to another.

In this matter, it would afford us much pleasure to hear how the substitution was carried out in America.

**Mr. A. W. Gibbs, reporter.** — During the transition period in America, we changed from the ordinary link and pin to the automatic type of coupler. The link and pin had been standardized previously as to height, there being a recommended height of 33 inches from the top of the rail to the center of the link. The automatic coupler was introduced with the hook moving in vertical plane, so cut out on the end of a knuckle as to take the same link, which was used with the previous link and pin coupler, and therefore it was necessary, in coupling the ordinary link and pin coupler to the automatic coupler, only to guide the link into the notch of the hook and drop the pin down. An examination of the tables of injuries to employees shows that this transition period was one of danger. I do not think it was as

serious a problem to us as it will be to the European roads, for they have to change from the vertical hook to the horizontal hook. One thing has developed in our use of the automatic couplers, and that is, that the plane of the coupler should be as nearly as possible the plane of the body of the car, as it has been developed very clearly that with the increased strength of the automatic coupler, the roughness with which trains are handled, has increased fully in an equal ratio. We have had some disastrous experiences where we endeavoured to use the coupler much below the plane of the body of the car, for the reason that with the eccentric loading that is produced by buffing, the sills buckle from compression at the lower edge and the whole end of the car goes down, so that the tendency of the best design of late has been to make the center sill as a column with the concentric load, or, in default of that, have as little eccentric loading as possible.

I neglected to state that there is one very serious difficulty which some railroads have to face. Where we have to go across the tide-water, the question of the vertical angle of one car with the next becomes a serious one, due to changes of tide. Owing to the question of strength and the fact that the automatic coupler is universal, the slot in the knuckle has been and is being eliminated. Where there is very great vertical angularity, such as going on float bridges, etc., it is a question whether we shall not have a serious difficulty in maintaining the cars coupled. Under that condition, we have not only the vertical angle of the two couplers, but also the vertical sliding of one over the other, producing very great vertical strains of the parts attaching the couplers to the cars. I believe that the coupler shown on the platform will probably cause trouble for the same reason.

**Mr. Sabouret**, French Western Railway. (In French.) — I should like to ask American engineers whether cars still frequently become uncoupled, especially on down gradients. Do trains often part owing to the couplings giving way in climbing gradient?

**Mr. J. E. Muhlfeld**, Baltimore & Ohio Railroad. — With quite a number of the automatic couplers that were put into service at the beginning of the transition period, the locks that secured the knuckles in the closed position were designed and arranged so that there was a liability, when cars were brought together and shocks took place, on account of the way the brake was handled, or on account of making severe stops or switching in yards, of the locks lifting. I think that was responsible in many cases for trains parting on the line. We still experience that trouble with such designs of couplers now in service on cars, although every effort is being made to remove them. That design was followed out more in connection with the malleable iron couplers which were first made use of in connection with freight cars. The later cast steel couplers, as now universally used on 80,000 and 100,000 pounds capacity cars, have been designed so that there is a center lift of the knuckle lock, and there is also a vertical gravity arrangement. Where the lock moves to unlock the knuckle, it moves in an upward vertical direc-

tion, sufficiently so that when it again drops, it gives a large bearing between the knuckle and the knuckle lock, and requires an unusual shock to lift it. About the only trouble we have experienced with the unloeking of the later designs of couplers, is where locomotives are run in tandem. The distance from the centres of the front driver wheel to the front of the pilot, and the considerable vibration of the tender when locomotives are coupled together, in curving and in going through cross-over switches on double tracks, causes considerable movement at the coupler which sometimes results in the locks creeping up, even with the couplers of the later designs; and we have practically come to the conclusion on the Baltimore & Ohio Railroad, that unless we can secure a knuckle lock of such adjustment as will prevent upward creeping, it will be necessary, on locomotives, to go to the use of a lock which is maintained in position by a spring, the same as we use on passenger cars.

For freight cars, we think that we now have couplers in use that provide for all features that are necessary to prevent parting. In a vertical plane coupler, as Mr. Gibbs has stated, there are quite a number of defects which still remain when it comes to severe conditions, such as moving across from floats to the permanent way, and *vice versa*. In commercial districts, where our cars are equipped with automatic couplers, we still have to make use of a special device to provide for the switching of these cars around a severe degree of curvature, because there is not sufficient flexibility in the coupler. We have somewhat neglected the lateral movement of the drawbar as a whole, which prevents the curving of cars and we find cars still have a slight tendency to derail on sharp curves. Of course, that does not apply on the main line, because any degree of curvature on the main line of the road can be taken care of by the vertical plane couplers, even when they are new and in a tight condition, provided sufficient lateral motion is given to the coupler at the end sill of the car. We have had cases where the center of the truck has been placed too far from the end sill of the car, and the coupler was not given sufficient lateral movement, which has caused a number of derailments on sharp curves, but where the center of the truck is kept well ahead towards the end of the car and about an inch of lateral movement given to the coupler at each side of the shank, we have not experienced that difficulty.

**Mr. Petri, German Government.** (In German.) — I may say that in Germany experiments on a considerable scale have been made in recent years with automatic couplers, as Mr. Nolte reports in his paper. The purpose of these experiments was twofold — first, it became necessary to strengthen our couplings, and secondly, it has been found necessary to prevent the many accidents which occur on account of the necessity of the train people having to stand between the cars to couple and uncouple, which we hope to avoid entirely. According to the general opinion expressed by the Association of German Railway Engineers, the construction of an automatic coupler, according to the American type, is considered very good

and suitable for this purpose, although it involves a very material increase of weight.

Generally, in our country, we are of opinion that there are two principal difficulties connected with the subject. The first one is how to get over the time of transition — the period during which the couplers are being applied — while you have the cars with the old style of coupler and cars with the new style of automatic coupler. The second question is about the shape of the two heads of the coupler, how these two pieces shall come together — the shape of this connecting piece is, of course, of the greatest importance. There is, for instance, one proposition made that the shape shall be in the form of a hook — figure 20, on page 64, of Mr. Nolte's report <sup>(1)</sup> —, but this form is not yet accepted. There are still going on experiments in Germany with different forms, and the question is which form would be the best and which form is to be adopted definitely. Mr. Gibbs has given details about the newest M. C. B. contour, which was applied in America in 1904, on page 72, figure 7, of his report <sup>(2)</sup>.

It is of particular importance to consider which level for the automatic coupler is preferable, whether to arrange it on the same level as the present hook for coupling, or whether to arrange it at a lower level. Therefore, experiments have been made in this line and they are still going on.

The Association of Railways in Germany and Austria have lately resolved to arrange a great number of new experiments in this direction on all the preceding questions, that is to say, to try the different shapes of hooks, and to try different levels of hooks — to try the hooks on the same level as the old hook and at a lower level than the existing hook — and to try how to get over the time of transition.

The question of the interior mechanism for coupling and uncoupling, is of course also of great importance, and the newest designs which are used in America give very excellent examples of it. Experiments in this direction are also going on in Germany. The main point which we have in mind is to do away entirely with the necessity of train men standing between the cars which, with some of the American shapes, could not be avoided entirely. Therefore, if we introduce a coupler, according to the American type, we want to adopt only such a construction as will do away entirely with the necessity of train people standing between the cars.

We are very well aware, also, that lately experiments have been carried out in France, for instance with the Boirault coupler, and also in other European countries. This is interesting and important to us, as we have been considering the question of finding out the best construction of an automatic coupler uninterruptedly. In Europe, this question has a particular international importance, because in my opinion we are obliged to adopt shapes which will be adopted internationally with reference to correspondence. As we have many cars running through the different

(1) Vide *Bulletin of the Railway Congress*, No. 1, January, 1905, p. 208.

(2) — — — — — p. 294.

European countries, the shapes which are to be adopted by us, or any other company, must be adopted by the different States, otherwise it would not be of any value. We think the question is very important, and I ask the gentlemen present if they have made satisfactory experiments with any new constructions of automatic couplers — according to the American or to any other type — to publish them as soon as possible, in order to make it possible to try these designs. We should be very much interested in securing all the possible information we can on the subject, and I should be very thankful if any representative of any of the European railroads, could give me information about any trials or experiments which are going on in this direction.

**Mr. Boell, principal secretary.** (In French.) — Mr. Petri has mentioned the Boirault coupling which is now being tried in France. I should like to say a few words about it.

The Boirault coupling has been specially devised so as to alter as little as possible, or even not to alter at all, the construction of European wagons. It can be seen in the extremely interesting reports published on this subject, and Mr. Noltein has recently recalled the point once more, that the application of American couplings to European wagons would mean a considerable increase in their dead weight and involve somewhat costly modifications in the bodies of the trucks. The expenditure might amount, if I am rightly informed, to no less than 1,200 marks (£60) per vehicle, which is no small sum.

Mr. Boirault's invention results in avoiding this expense and also enables the transition to take place in a few minutes, one might say, and with almost no labour. Without the help of a model and a drawing, I find it very difficult to give a satisfactory description of this appliance which works exceedingly simply. Any who are interested in it can, however, find a full description of it in the *Organ für die Fortschritte des Eisenbahnwesens*. Another description, but rather a bad one, will be found in the French *Revue technique*. The appliance is now being shown at the Liège Exhibition, where many of you will have an opportunity of seeing it. I shall, moreover, be very pleased to show anybody who likes, the working of this coupling in France, and I believe the *Railway Age* intends to publish a short description of it before the Congress closes. (*Vide Appendix II.*)

The apparatus itself consists of a horizontal, nearly rectangular extensible frame. The frame consists of one relatively fixed part hung from the eye of the drawhook, and carries two slides on which two links which carry the head of the coupling can move. A spiral spring, resting on the coupling, keeps the frame extended but allows play for it.

The coupler head is hung on slides by two trunions. Thanks to these arrangements and to guides suitably disposed, the accurate adjustment of the coupler heads is assured even under the most unfavourable conditions.

The coupler heads really form a lock containing two bolts, and showing outwardly

two openings and two projecting wings of D-shape into which the corresponding bolts can take. When the two heads come in contact, the two D-shaped wings take into the two openings and the two bolts automatically take into the two wings. Thus there are four bolts which secure the coupling, and consequently, it has very great strength.

The bolts are operated by a lever, which can move about its centre, and this is operated itself through the spiral spring already mentioned.

This spring has two functions : it tends to extend the frame and its torsional force always tends to keep the bolts closed ; but there is a catch which prevents this closing when not required, and which rises when the two coupling heads come into contact, thus causing the bolts to lock.

All that is required for uncoupling, is to pull, by means of handles, the chains fastened at the ends of the lever which control the bolts.

The apparatus is kept in its horizontal position by means of a bridle which hooks on to the drawhook. From ten to fifteen seconds are enough for detaching this apparatus and letting it drop vertically, and then the old coupling can be used ; this tends to facilitate greatly operations during the transition period.

For several years experiments have been carried out on the French State lines ; the earliest date back five or six years, but for two years only has the coupling been used in its present shape.

A certain number of 20-ton wagons have been fitted with it, and though they have been subjected to the most arduous tests, the appliance has never failed or given rise to any accident. We have driven the wagons into one another ; we have succeeded in bending cross-pieces and buffers, but the coupling itself has never been injured in any way. Similar tests have been carried out in Berlin at Tempelhof and, I believe, with similar satisfactory results.

This coupling, therefore, possesses serious interest from an European standpoint. Each weighs from 60 to 80 kilograms (132 to 176 lb.) which is an insignificant amount. The cost is trifling, and transition can take place in a very short time. A ministerial circular has lately been sent out in France inviting the railway companies to test this apparatus on a large scale, and we may therefore shortly expect complete results. It is to be hoped that similar trials will be undertaken in the different countries of Europe because the subject is, above all things, an international question. For railways that connect and have a similar gauge, no decision can be taken individually. It is, therefore, desirable that some general decision should be arrived at in this respect.

**Mr. Brisse**, French Eastern Railway. (In French.) — I should like to make a few short remarks so as to define the point of view accepted more especially by the traffic department of my company with reference to adopting automatic couplings some day.

As Mr. Petri, representing the German Government, has said, the subject must necessarily be regarded in Europe as an international question. It can never be

settled individually for such and such nation or for such and such a country, except in the case of Russia and Spain which have gauges different from those of other countries. The constant and necessary interchange of rolling stock between the different countries of Europe make it absolutely essential that any solution shall apply to all these countries.

There is another point more of a financial nature that I should also like to bring forward. It concerns the transition period.

It seems to me that any railways interested in the subject must necessarily give the preference to an apparatus the fittings of which could be prepared beforehand, and one that could be put into service on any pre-arranged day. The introduction of the coupling ought to be instantaneous, and the transition period would thus be virtually abolished.

**Mr. Sarre, German Government.** — I want to state in addition to what has been said by Mr. Petri, that I have seen the Boirault coupler in the workshop at Tempelhof near Berlin, where Mr. de Dietrich of Niederbronn had exhibited two wagons that were fitted up with that coupler. From what we saw we had the impression, that the Boirault coupler, in its present shape and dimensions, is not constructed as strongly as would be necessary to give permanently satisfactory results in point of maintenance and heavy work. We anticipate that it will be necessary to strengthen the Boirault coupler, and we are of the opinion that it will have in its definite shape a much greater weight than it has now, and in consequence it will be much more expensive than it is now. The Prussian Railways are now making experiments with Boirault couplers. We would be glad to hear of experiences gained by other French engineers or those from other countries who are making trials of this coupler, as to the general opinion of it, as to cost of maintenance and its application to heavy work.

**Mr. Boell. (In French.)** — It will be quite easy to increase the strength of the Boirault coupler without markedly increasing its weight, and in any case, its weight will be considerably less than the weight of the M. C. B. coupler.

**Mr. Laurent, Orleans Railway, France. (In French.)** — I should like to tell you my company's views on automatic couplings with special reference to the Boirault system.

Until the Boirault coupling appeared, not a single test of any automatic coupling had been carried out in France. The American coupling did not seem to us perfect from a purely technical standpoint, and besides, the disadvantages often pointed out and especially by Mr. Sabouret, we considered that the application of this American coupling to our European rolling stock would, as Mr. Boell has said, involve expenditure quite out of proportion to the object in view.

It was, therefore, with much interest that we saw appear a new automatic coupling which, as it could be adapted to the old couplings, rendered it possible for us to

consider seriously the question of introducing automatic couplings. But the experiments which have been carried out on the French State railways, however interesting they may be, are, properly speaking, merely laboratory experiments. These tests applied to ten vehicles only and, moreover, the cars were used on special service.

The tests are not sufficient to decide the real value of the Boirault coupling. There are many questions still unanswered, especially the one just asked by Mr. Sarre : Is the Boirault coupling strong enough?

In France, we are convinced that with the European coupling we can get sufficient strength. We are now making couplings in France which stand a maximum pull of 55 tons (54.1 English tons) while retaining the shape and arrangements of the ordinary European coupling. It is not, therefore, impossible that the Boirault coupling can be constructed of equal strength and, to meet requirements, it must be so manufactured. But the matter has not been yet worked out.

We think therefore, that further tests ought to be made and my company proposes to do so. We are of opinion that the question of using automatic couplings is perhaps not so urgent as it was in America.

American rolling stock was quite differently arranged as compared with European stock; central coupling might make coupling and uncoupling more risky. With our lateral coupling, rendered obligatory by the Berne Convention, obliging companies to leave a certain amount of room for the man whose business it is to couple up, it appears to be demonstrated from all the statistics of accidents, drawn up very exactly and minutely in France, that we did not have as many coupling accidents as in the United States.

Nevertheless, we recognize that automatic couplings may be an improvement. We intend to take much interest in the subject, but we withhold our judgment as to whether automatic couplings ought to be adopted. Above all things, we desire to convince ourselves whether, in the first place as regards accidents, and as regards speed in shunting and economy, automatic coupling is likely to make up for the enormous cost involved in its adoption.

To sum up, we intend to study the Boirault coupling further, not only as regards its technical value, but also the advantages it may afford. We hope that later on, after the trials which we are arranging with the manufacturers to undertake, we shall be in a position to publish some interesting data.

**Mr. Baltzer, German Government.** — Am I right in understanding the number of cars which have been equipped with the Boirault coupler is twenty? That would be a very small number, indeed, because in a question of such great importance the trial must be made on a large scale; and for that reason, as has been stated, the German railroads have resolved to go into these trials on a large scale, and to try several forms of couplers, including couplers of American construction. Therefore, I think it would be a very good thing if this session at Washington could induce all

the railroads in Europe which are interested in this question to take up the testing of these couplers. I would ask all of the delegates from European railroads, as far as they are interested in this question, to do what they can to go into these trials on a large scale, because only in that way will it be possible to get results of any value. I think we should be very grateful if the present session of the International Railway Congress were to be the means of causing these trials to be made on a great scale, and I hope through these trials, we may secure a coupler which will answer all the purposes for which a coupler is designed.

**Mr. Boell.** (In French.) — The tests in question were conducted, not on twenty, but only on ten vehicles. These were only preliminary experiments, after which the matter was investigated by the Railway Technical Committee, connected with the Public Works Department. Owing to the extremely favourable report issued by this committee, the minister for Public Works suggested that all the French railways should carry out experiments on a large scale, and these will obviously cover some hundreds of vehicles.

Moreover, negotiations were undertaken with the company that owns the Boirault patent, and when I left Europe nothing remained to be settled except the question of price.

By the time I get back I have no doubt I shall find that an agreement has been arrived at, and we shall be in a position to make experiments with a fairly large number of cars.

**Mr. R. Fane-de-Salis,** North Staffordshire Railway, Great Britain. — I should like to say a few words on English needs and experiences. We have had on my line for the last three years two trains making Stoke their head-quarters fitted with the American M. C. B. couplers. They are the property of the showmen, Messrs. Barnum and Bailey, and our experience with them has not been satisfactory. Both our officials and our men state that these couplers are not as quick in action nor as safe as our hook and eye coupler. They are sometimes difficult to operate and often fail to couple on curves, and if one car is heavily loaded and another car is light, the coupling is apt to jar undone. For our English purposes, we want a coupler which must be fairly light, which must not be expensive and which must be capable of use with wagons either with spring buffers or with the old wooden buffers. There must be a long period of transition, and for this reason — in such a district as mine, the Midlands of England, about two-thirds of the wagons are the property of private traders.

I wish to draw attention to one statement in Mr. Pettigrew's paper, in what was put forward as his conclusions, but which is a quotation from a report made in 1899, in which he states that many wagons on railways are fitted with stiff couplings, to uncouple which it is necessary for the men to go between the wagons. That may have been true in 1899, but it is not true in 1903, at least certainly not for our Midland districts. I might also say, as to the question of safety, that Mr. Bonar

Law was speaking quite recently in Parliament for the Board of Trade on this question of couplers, and he stated that he could not recommend at present the compulsory use of automatic couplers, because he was advised by his officials of the Board of Trade that the hook and eye coupler which we use in England for wagons, was safer than any form of automatic coupler at present before us. I may say that I heard with great interest the description of a French coupler which was given here, and I should much like an opportunity of seeing it. We have not yet seen it in England.

**Mr. Petri.** (In German.) — I have heard with great interest the experiences which have been communicated here from the delegates of French railroads, but I wish to mention that other countries also might make experiments with good constructions as soon as possible. It is my opinion that the Boirault coupler is only in its infancy, and it is not possible to give a definite judgment about it now. With reference to the number of cars which have been fitted with the Boirault coupler, I beg to state that in Germany, many hundreds of cars have been tried with other automatic couplers. I also wish to say that the experiments which we have made with American couplings have given us so far quite satisfactory results. One must not forget that much weight should be attached to the results which have come out on the trials which have been the basis of American couplings, which generally give satisfactory results here in the United States. Therefore, I wish to point out that it cannot be considered that the Boirault coupler is in the same position as the American couplers which have been tried on a large scale. I also wish that other systems may be tried on a larger scale. In that case, a comparison will enable one to form definite ideas on the subject.

**The President.** (In French.) — This question of automatic couplings is certainly one of the most important with which the Congress has to deal, especially from the standpoint of its possible practical results. I need no stronger proof than the interest you have taken in this discussion.

But we shall be bound to cut this debate short so as to finish it to-day. We have on our agenda paper other questions of great importance likewise, and they will similarly give rise to rather lengthy discussion.

— The meeting rose at 12.20.

---

**Meeting held on May 10, 1905 (afternoon).**

---

**The President.** (In French.) — We shall now continue the discussion commenced this morning. Lieutenant-colonel Yorke, delegate of the British Government, told me that he wished to speak. While awaiting his arrival allow me to remark that the

subject of this discussion can be subdivided under two quite separate heads. On the one hand, there is the subject of the technical details of the automatic coupler, its resistance and tensile stresses, the number of operations requisite for its use, and, from this latter point of view, different solutions may be recommended according to the arrangement of the vehicles and local circumstances.

The second part of the subject, which has not yet been touched upon and which is, nevertheless, the one which dominates the question, is the security offered in coupling and uncoupling.

This is not a matter of opinion, but really a question of statistics, and it is to be hoped that we shall get some exact figures upon this side of the question.

It appears as if there were a tendency to regard non-automatic systems in general as extremely dangerous. This view has arisen, perhaps erroneously, by confusion with the old American couplings which did give rise to many accidents.

This matter of statistics deserves careful attention, and it is to be sincerely hoped that we shall receive information on the subject.

By subdividing the discussion in this manner we shall, moreover, be able to draw up our conclusions more definitely.

**Mr. Asselin, French Northern Railway. (In French.)** — As at present advised, there are some reservations I feel bound to make on behalf of the Northern of France with reference to the application of automatic couplings.

The company founded to manufacture and extend the use of automatic couplings intended to avoid, as far as possible, the accidents to which the men who have to go between the buffers to connect and disconnect vehicles, are daily liable.

Obviously, the accidents which occur deserve most careful attention and the greatest solicitude on the part of railway companies. It is a question of humanity as much as of professional duty.

As regards the Northern of France Company, we have for several years past most attentively and carefully tried to find out how many accidents of every kind have taken place, and also to determine their causes, so that by recognizing the exact cause we should be enabled to do all we can to abolish it, or at least to render its recurrence unlikely.

For the year 1904, for instance, we found that out of 100 accidents occurring to the staff, 5·29 were due to lack of regard for the general regulations;

18·79 were due to want of observing the local safety signals referred to hereafter;

59·85 were due to lack of skill or imprudence on the part of the sufferers;

16·03 were due to various chance causes.

We further discovered that the accidents to the men were more frequent amongst recent employees who had only seen five or six years of service at most. In view of this, we undertook a strenuous campaign in order to do away with the causes of these accidents. We insist most strictly upon the regulations being observed; we established at each station a special signalling staff to draw the men's attention to

the points and the times at which owing to its greater difficulty the service demands greater precaution; we instruct our men, and more especially the newcomers, with regard to the precautions they must take to protect themselves from accidents, and we most carefully supervise the new as well as the old employees to see that they observe these precautions. Accordingly, we do not hesitate to fine men for neglecting these precautions, even if no bad consequences follow such neglect, even if a man is zealous enough to want to carry out an operation more quickly by avoiding the loss of a moment but in doing so fails to realize that the small saving in time, for instance, that he desires to effect, is not worth the risk to which he is exposing himself.

This regular campaign has been really efficacious; for the number of accidents to employees which in 1903 amounted to 921 <sup>(1)</sup>, of which 45 were fatal, fell in 1904 to 762, of which 32 were fatal, a decrease of nearly 18 per cent as compared with 1903.

But of these numbers, still excessive, which we are doing our best to reduce, what proportion occurred during coupling or uncoupling which might perhaps be modified by the use of automatic couplings? In order to answer this question, we have examined *one by one* the records of accidents since 1898, and comparing them with the above figures, we find no more than 29 accidents in 1903 — two of which were fatal and 20 accidents in 1904, with (since 1898) an average of 27 accidents per annum of which less than three were fatal.

It will be noticed that the percentage of accidents due to couplings (barely 4 per cent) is quite trifling as compared with that due to other causes and that, under those circumstances, our energy must be concentrated upon the 96 per cent due to all the other causes, because it is here that we can do much in saving life.

But we have gone a step further, and we have compared our returns with those of the United States, which clearly demonstrate the happy results following the use of automatic couplings from the standpoint of the safety of the staff. We have seen that on the Northern Company's line, we had on the average 27 accidents, of which less than 3 (exactly 2·6) were fatal, per annum. Compared with the total number of men employed, that works out per 100,000 men, 57 accidents of which 5·5 were fatal. In America, the *official* returns per 100,000 men give 243 accidents of which 16 were fatal.

We are far behind this figure with our double buffers and our non-automatic coupling, and it will be easily understood how loth we are to make an experiment with so little encouragement.

But there is another point. Our company connects directly and consequently exchanges vehicles with the whole of continental Europe, except Russia and Spain, which have a different gauge from ours. Now, to get the full benefit from auto-

---

<sup>(1)</sup> It is to be noted that as the smallest accident must be returned, a very large number of trifling accidents is included in the figures given.

matic couplings, they would have to be universal and interchangeable and the transition period which lasted not less than seven years in America, as we have been told by one of the reporters, is a particularly trying time so far as the safety of the men is concerned. How many human lives would be sacrificed during this period and how many would be saved subsequently considering the figures I have given you? This is the question we are asking ourselves, and our opinion is that the balance rests with the disadvantages.

We think, therefore, that much reflection is essential before travelling in this direction. If investigations or experiments are carried out, we shall not fail to follow them with much interest, but we feel obliged to pause until we know for certain what conclusions will be reached.

**The President.** (In French.) — Gentlemen, you have just listened to some statistics with reference to the safety of employees on the Northern of France Railway. Cannot some one give us similar data for other countries or other companies in this matter of safety, which is the very foundation of the proposals in favour of adopting automatic couplings?

**Mr. W. McIntosh,** Central Railroad of New Jersey. — The old link and pin couplers required careful handling of the cars in order to allow the switchmen or brakemen to make the connections. Since the introduction of automatic couplers, but little attention is given to careful handling of the cars, the result being that it has been found necessary to strengthen the sills and parts of the cars to which the couplers are attached. Cars are handled now very carelessly and the introduction of the automatic features on European lines will bring about the same troubles there. When the first automatic couplers of the vertical plane type were being applied in the United States, the equipment then used was much lighter than it is at present, the cars being 40,000, 50,000 and 60,000 pounds capacity, and many of the couplers that were applied to this equipment were of the malleable class and much lighter than we are using at present. During the past ten years, there has been practically a revolution in the weight of equipment. We have during this period increased the capacity of the cars to 60,000 and 80,000 and 100,000 pounds. This has called for much stronger couplers, and we are now using steel almost exclusively, and the sections are made larger than formerly. Naturally, with many of the small capacity cars still in service with the lighter couplers, there have been failures. But notwithstanding this, there has been a very evident diminution in the number of failures, until at the present time, it is an unusual occurrence to have a failure of any kind with the couplers in passenger equipment. The failures in freight service are decreasing rapidly, and are more attributable to carelessness in handling the cars in shunting than to any strains that are applied to the cars in their natural movement along the line.

**Mr. J. E. Muhlfield.** — Mr. President, I have no statistics as to the failures of

couplers, or the security from personal injury, with the automatic type as used in the United States but from the fact that the tonnage handled in the United States, during the past ten years has almost doubled in freight service, and as there has been a large increase in the number of passengers handled and trains moved, this in comparison with the yearly records of personal injuries would indicate that there has been a decided advantage through the use of the M. C. B. type of coupler. When this coupler was first put into use the general run of cars were, as Mr. McIntosh states, from 40,000 to 60,000 pounds capacity, and since that time, with the development of the coupler, there has been a radical increase in the capacity of the cars, these running now from 60,000 to in some cases 120,000, the majority being 100,000 pounds capacity. The first couplers put in service were of malleable iron and the design was such as would permit of the opening and closing of the knuckle only. The couplers now in use are of cast steel and they are designed so as to admit of several additional operating features that are necessary for the present requirements. With the gravity system of classifying cars in yards, it is necessary to have a means for lock-setting which will permit of the switchmen lifting the lock of the coupler when two cars are actually in contact, so that later on, when the cars pass over the hump, it permits them to part without any further operation. The lock-set has been developed, and with it a method has been devised for releasing it. That is, in case two cars are coupled together and the switchman makes a mistake by lifting the lock and later, finds out that he doesn't want to uncouple those cars, he can go back and release the lock set without pulling the cars apart and again recoupling them. Besides, the present couplers are designed so that when the knuckle is opened it is automatically thrown out, so there is no necessity for the switchmen or brakeman to go between the cars or right in front of a car, and this was not the case with the couplers as originally designed. We now have in the majority of couplers the central lift; that is, the lifting of the knuckle latch is from the center draught line, whereas in a great many old makes of couplers this was from one side of the coupler, and there was a good deal of difficulty experienced on that account due to the coupler head lateral movement. The coupler designed to-day, also permits of automatic unlatching of the knuckles in the event that the draught gear becomes detached from the underframe of one or both of the cars coupled, and which prevents a coupler from being pulled out and thrown on the track. This was a feature not contained in the old couplers, and which was responsible for a great many accidents that now seldom occur. Take it all the way through, the M. C. B. coupler as to-day designed, and as it has been used for the last two or three years, is very well adapted to the modern conditions of the American railroads, and there is no reason why if properly attached to the cars, with a good substantial type of draught gear, we should have the same trouble as we did when the coupler was first brought out, except where cars of the lighter capacity and the heavier capacity are coupled together. In those cases, it is usually the failure of the draught attachments and not the coupler itself that is responsible.

Now, with regard to the points that Mr. Petri this morning brought out relative to the contour of the knuckle, the contour that was adopted last year, the M. C. B. contour, is more favourable than the previous one. The knuckle contact faces before were made rather flat instead of recessed in order to give a good bearing. As this part of the knuckle wore away, during rainy weather, and especially on heavy trains, the knuckles would tend to slip past each other on straight track. That occurred when the conditions were most favourable for parting, and where the locks would not open, the couplers would part, due to lost motion at the pivot pin, wear at the knuckle face, and wear at the bearing between the knuckle and the lock. That has been largely overcome by the new contour, which, while it gives a little recess to prevent the pulling of the knuckles past one another, at the same time does not produce a shearing stress, and does not reduce the area of knuckle contact to such an extent as would cause failure of the knuckles at that point. With the type of hook knuckle that has been proposed, for our service with the heavy trains and heavy capacity cars, we feel that the point of contact will be too small and there will be a liability for shearing and breakage over that which will occur with the present design. In addition to this, in the present good designs of couplers, the tendency is that as wear takes place at the pivot pin and between the lock and the knuckle, it increases the bearing surface between the lock and the knuckle instead of decreasing it. In the first design of couplers, there was a great tendency when wear took place, to reduce the bearing surface between the knuckle and the lock, and which gradually permitted, under excessive strain, the opening of the knuckle without the lock lifting, but in the majority of the present designs, as the coupler wears, the area of the surface and contact between the knuckle and the lock increases, instead of decreases, which should overcome that difficulty. I think that with the exception of the draft attachments, and by giving the couplers in use to-day a sufficient amount of lateral movement at the end sill, the Master Car Builders' coupler meets the present requirements about as well as an automatic coupler can. The weight of our present couplers for freight service averages about 250 pounds for cast steel, and for passenger service, about 175 pounds, for malleable iron. That weight includes the increased length and size of shank to admit of the use of the improved types of draft gear, etc., and the couplers to-day will stand a tensile strain of from 300,000 pounds upward, which is more than adequate for any requirements either in switching or in handling trains over the line. In the development of the automatic coupler for foreign railways, while you have not the same car construction, it seems to me that a bracket arrangement of securing the coupler to the end of the car, and the use of springs to take up the compressive and the pulling stresses, could be worked out to good advantage with the M. C. B. type, and at the same time come within the limits of your buffer clearances, that is, the distance from the end of the buffer when it is under compression and the end sill of the car.

Of course, an M. C. B. design of coupler for a car of 20 tons capacity can be made very much lighter than the coupler such as we use for a car of 100,000 capa-

city, and which must be designed so that you can switch those cars over hump yards and at the same time operate them automatically. The very fact that the switchmen are not now required to go between cars to effect couplings should confirm that we must have less liability to personal injury. With the old method of coupling, it necessitated a man going between the cars, whereas with the present coupling that is not done and it is not necessary. While in a great many cases we have brakemen ride those cars in hump yards where they are classified, and see that the impact is not severe, or so great, so as to result in damage, yet that is not the general rule, and the cars are switched over humps of considerable gradient and left to go down in the yard, and the impact is depended upon to couple the cars into trains.

**Lieutenant-colonel H. A. Yorke**, Board of Trade, Great Britain. — I have to apologise to you, Sir, for being late in coming before you, but circumstances over which I had no control and engagements of the utmost importance detained me down stairs. I hope that you will pardon my delay.

I appear before you as a student and not as an instructor. I do not propose to occupy your time to any degree, except to ask one question. In England we have before us two problems at the present time which are engaging a great deal of attention. One is that of automatic coupling. The introduction of an automatic coupling suitable for our freight stock is of great importance. The other is the building of our freight stock with the automatic, continuous brake. Those questions seem to me to be very intimately connected. The object of an automatic coupling is principally to prevent the necessity of the railway employees going between the wagons in order to couple them together. In England, we are able at the present time to render it unnecessary for men to go between the wagons to couple them together, by the use of the coupling stick which is an article of every day use throughout the railways of England. I therefore do not propose to dwell upon that subject at the present time. But it is no use rendering it unnecessary for a man to go between the wagons to couple them together if he subsequently has to go between the wagons to couple the brake pipes together; and what I am anxious to learn is what the experience in America has been as regards the automatic coupling of brake pipes. I have seen some inventions at the Washington exhibition (and in fact I have seen them on previous occasions), which automatically couple together the brake pipes and any other pipes that may be necessary to run through the train. Whether those appliances have yet got beyond the experimental stage, I do not know, and I should be very glad to receive any information on that particular subject, it being one which undoubtedly will have a considerable bearing upon the question of the adoption of automatic couplings in Great Britain.

**The President.** (In French.) — Could anybody give Colonel Yorke the information he requires?

**Mr. J. E. Muhlfeld.** — Mr. President, Colonel Yorke has stated that the application of the automatic coupler is mainly to prevent personal injury to employees. I agree with him that that is the principal reason for their application. Another reason is to facilitate the switching out and handling of cars at terminals, and especially at classification yards. With the introduction of hump yards and gravity systems of handling cars, the terminal delay to trains that must be switched in order to make solid trains for certain destinations, has been very materially reduced. It is now practicable to classify incoming trains and divide them into groups of trains for five, six, seven or more destinations in probably one-quarter of the time that it took to classify similar trains with the old methods when we had the non-automatic couplers. That is for the reason that an entire train as it arrives in the yard is immediately picked up by a switching locomotive and pushed over the hump and the scale tracks, and the cars are distributed automatically to the different banking tracks. Whenever we get a train of cars on any banking track of the maximum that can be taken out, a road engine is coupled to that train, and they cut off whatever tonnage can be hauled and go out with it, and the process of switching still continues. Now, the method of coupling cars together, in my opinion, is entirely different from the method of coupling the brake and signal and steam pipes. When cars are coupled together, either both or one of the cars are moving, and in some cases in gravity yards, two or more cars are moving when they are coupled. When it comes to the coupling of the air hose, that is done after all the cars have stopped motion. There is no movement of any of the cars. The car inspectors and the men that inspect the brake apparatus, adjust the travel of the brake cylinders, etc., go over a train of cars and couple up the hose. We have the air-brake test pipes in the yard conveying compressed air to each outgoing track, and air connection is made from the roundhouse compressor in that manner to the train. The train brake-pipes are tested for leaks, the couplings are tested for leaks, the piston travel is tested and adjusted, and by the time the locomotive is coupled to the train, the entire train air-brake equipment has been tested and is in condition to go forward. The fact that there is no necessity for the movement of a car to couple the air-brake or the steam heat or air-signal apparatus, I think, insures against accident on that account. While there may be some accidents that may have occurred in connection with passenger trains where men have coupled steam hose or air-brake hose at the terminals, that is something that is the exception rather than the rule. I do not know of any case in any of our freight yards, and in some of them we handle three or four thousand cars a day. The operation is entirely different, as in one case you must have at least one car moving to effect the coupling. In the other case, it is not necessary to have any car moving to effect the coupling.

When it comes to the automatic coupling devices for air-brake and signal hose and steam heat attachments, they are now under development. We have a train that has been in service for a couple of years with those attachments, and it is being tested. It is not satisfactory. We are waiting for further developments, and when

that apparatus is perfected it will no doubt be given due consideration for use the same as the M. C. B. coupler.

**The President.** — You say it is satisfactory?

**Mr. J. E. Muhlfeld.** — No, it is not, but I say when it has been developed to a satisfactory extent, that is, so that on 20° of curvature, with the couplers at the maximum and minimum limits in height, with the various other conditions you have in practical service, and when you can effect an arrangement that will not necessitate the use of rubber hose and will absolutely couple the air-brake attachments and the steam heat and the air signal at the same time that the coupler is coupled through the movement of the car, I think that it may be used to some extent, although it is not necessary to secure against personal injury.

One of the defects, if it can be so considered, in air brake equipment, is the use of rubber hose, which even with rigid specifications and tests and vigorous inspection, will frequently fail due to abuse in service, and from which bursting results when under train pipe pressure. When one of these hose bursts in a moving freight train on the line of road, all brakes automatically go into emergency action and frequently results in the buckling of cars, etc.

With the present method of hand coupling the train pipes, it is of course, necessary, that a flexible material such as hose be used. If, however, automatic couplers can be perfected to fully meet the requirements, the connection between the train pipe and the coupling head should be made by piping and flexible metallic joints.

One of these partly developed automatic couplers, now being used to a limited extent in connection with passenger equipment cars in this country, is the Forsythe device. In this arrangement, the use of rubber hose is entirely dispensed with, and this we feel is in the line of improvement.

**Mr. W. McIntosh.** — Mr. President, I simply want to state in connection with Mr. Muhlfeld's remarks, that there is a small division of the New York Central where passenger trains are operated with this self-coupling device for air and steam, and the Long Island Railroad is operating a number of trains successfully with the same device, which is of Westinghouse make.

**Mr. Sabouret.** (In French.) — The act which obliged American companies to introduce automatic couplings enacted at the same time that the continuous brake should be used. Attempts to connect automatically the air brake pipes are of quite recent date, whereas automatic coupling was settled more than ten years ago. Should we expect similar independence in solving the problem if automatic couplings were to be applied to European rolling stock? I think not.

European vehicles have buffers while the American have none. For the men to go between two coupled vehicles to manipulate the brake and heating pipes is therefore much easier with American cars than with European rolling stock. So,

if we continue to investigate the automatic coupling of European vehicles, supposing we desire to retain buffers, it will be prudent, I think, to consider likewise the automatic coupling of brake and steam pipes. If this is not done, we shall only get part of the advantage that may be expected from automatic arrangements.

The two American appliances for coupling pipe connections which we have had the opportunity of seeing at the Washington Exhibition are only possible with automatic car couplers. One is added when the other is already in existence, and under these circumstances, these appliances become comparatively costly and complicated. The Boirault apparatus, on the other hand, renders it possible to get in a very simple manner both automatic car coupling and at the same time coupling of the brake and steam connections; that is a very important advantage.

**Mr. F. G. Wright**, Great Western Railway, Great Britain. — I should like to ask a question of the last speaker. Is it not a fact that it would be very much safer to go between the vehicles of a European train, on account of the side buffers, than to go between the cars of an American train that had the central coupling?

**Mr. Sabouret.** (In French.) — Suppose a man between two vehicles a little distance apart. He wants to get out. He cannot always get under the buffers; so he risks being caught between them. Such a thing could not occur with American rolling stock.

A delegate said it might happen that cars should be close together and that under these circumstances there would not be much danger.

Another delegate suggested that the man might get out between the buffers. I do not exactly know, added he, whether Mr. Sabouret means that the risk arises only when the vehicles are a short distance apart, does he?

**The President.** — Yes.

**Mr. E. B. Dolby**, *secretary-reporter*. — The danger is only when the cars are some distance apart.

**Mr. F. G. Wright.** — If you walked between the cars in American stock, and the one car moved, you would be instantly killed. That is so, I understand. But if you were standing between cars of a European train and the cars came together, unless you happened to be in the plane of the buffers, which is very improbable, you would be perfectly safe. With the European cars, with side buffers, if the vehicles come together, the man is in a safe position, and if he wants to get out he naturally goes underneath the buffer; but with the American vehicle, if they come together, and they cannot couple unless they come together, the man would be instantly killed.

**Mr. A. W. Gibbs**, *reporter*. — Some of the gentlemen may not be aware that in former times side buffers without springs were very generally used in American

cars. They were used largely because the coupler then used was not adapted to resist the impact. Therefore, these buffers were placed there to take the impact, and the coupler was put there to take the pull. These side buffers were generally known all over America as "man-killers". That was the general name. I think they were known by that name quite as much as by the word "buffer". They were dangerous when a man had to walk between the cars, they were dangerous when a man had to reach between to couple, so that it was a common thing to see a man stoop and reach out so as to put the pin into the coupling, and I think that it was the crushing of arms by those buffers which did quite as much as anything else to cause the agitation that led to the adoption of the coupler. I think probably Mr. McIntosh or some of my other colleagues will bear me out.

**Mr. W. McIntosh.** — I will corroborate Mr. Gibbs' claims in that connection; and I wish to say just a word in regard to Mr. Wright's statement, wherein, if I understood him correctly, it was his impression that if a man stood between the cars of the American type, on either side of the coupler, when they came together, he would be instantly killed. That would not be the case, because after the couplers are in impact, there is still room enough on either side to allow a man to stand without injury.

**Lieutenant-colonel H. A. Yorke.** — I am very obliged, Sir, to Mr. Muhlfeld for the information that he gave in reply to the question that I put, which makes it perfectly clear that up to the present moment there is no coupler known in America which is satisfactory for coupling brake pipes and steam pipes or any other pipes that run through the train. But Mr. Muhlfeld explained that after the train had been coupled automatically by means of the automatic coupling in use in this country, it then had to stand for a certain period of time during which the air pipes were connected through the train and some test was made of the brakes and a certain examination of the train took place. It seems to me that the delay that occurs in this manner after the train has been automatically coupled, seriously discounts the advantage of the automatic coupling, because if the train after having been coupled together has to stand for some time while certain other arrangements are being made, that time might just as well be utilized for coupling the cars together as for coupling brake pipes together. Certainly, if that is the case in America, I think that we would couple a train together in England and get it away quicker than they do in America, because our men go along with a shunting stick and connect the cars together by means of the three-link coupling in an exceedingly short space of time, and when that has been done there is nothing more to do. We have no further delay, we have not to make these various tests of brake pipes at the present time; and what I hope is that whenever we do get an automatic brake fitted on our freight cars, that brake will be coupled automatically.

Mr. Muhlfeld said that the time occupied in coupling trains in America at the present time is one-quarter of the time that used to be occupied in former days.

That may be quite correct as far as American appliances are concerned, because in America in those former days they had the link and pin coupler which was an appliance which did not lend itself to very rapid handling; but again I say, with our three-link coupler in England, and the coupling stick, the time which is occupied by a man who is expert in the use of that appliance is very small indeed, and I do not think that the time that would be saved by the introduction of an automatic coupler would be so great as a quarter of the time that is now occupied by the hand appliance.

**Mr. Dugald Drummond, London & South Western Railway.** — In Great Britain and Ireland the railways possess something like 2,193,000 vehicles, so that any departure from the present arrangements now on these railways as to coupling up, would be a very serious matter unless we were assured of something better than we already possess. So far as I can see, the couplings in America would not serve our purpose as well as those we have already in our possession, for the reason that, in my opinion, they are not elastic enough. I am quite agreed that the center coupling is a desirable thing if you can get one that is reliable, and if at the same time it meets all the requirements of safety, both to the rolling stock and in the transit of goods and to the men employed in the operations of shunting; and I should like, therefore, to ask some of our American friends what their experience is in the damage to goods in transit with the mode of shunting which they have adopted, and also as to the tear and wear of their stock, either in freight cars or mineral cars in the shunting operations due to the shocks they receive from the present arrangement of coupler and buffer. I am informed that it is very serious, the damage to goods, and very serious to rolling stock. I should like to have this confirmed by several of our American friends who have had a long experience.

**Mr. J. E. Muhlfeld.** — Colonel Yorke referred to my remark to the effect that we had reduced the time one-quarter for coupling of cars. I think if the secretary will read over the remarks, we shall find that I referred to the time for the classification of cars and trains. That is, instead of keeping a switch engine attached to a string of cars and switching backwards and forwards over the various leads in the yard to place the cars on the different tracks, we now use one switch engine and that switch engine gradually pushes those cars head on over the hump, and they are dropped down by gravity into the different tracks, and it is in the classification of the cars from incoming trains that we have reduced the time and not in the coupling. The coupling is automatically taken care of by itself, even when the cars are in motion. I have seen, in these yards, three cars couple themselves automatically when each of the cars was in motion and going down toward the end of the yard, depending entirely on the acceleration. In the saving of time on account of the coupling of cars, there is no doubt that if you can switch cars down tracks and have three of them in motion at the same time, or more, and have those cars couple themselves, during that operation, there must be some saving as compared with

running up to a car with a locomotive attached and depending on a man to couple it.

When it comes to the time taken up with the coupling of hose, we have not yet in service on American railroads a car with an automatic brake that does not require some time to charge the reservoir under the car in order to get the storage of air required for the automatic feature. Now, with the straight air, of course you are entirely dependent on the pressure from the engine direct through the train pipe; and you carry no storage under your car, but with the automatic brake it requires some little time to charge the containers that are under each car, in order to get the required amount of air with sufficient pressure to make the terminal test of the brakes, to see that they are in proper working order, and during the time that these reservoirs are charging, two men, one on each side of the train, can go from the head or rear end where your train pipe connection is made to the yard testing plant or locomotive to the rear of the train and couple up the hose and test them as rapidly as you can charge the reservoirs under the cars, so that really the delay is due to the charging of the reservoirs under each car in order to get the required pressure to make the terminal test and to start the train. We cannot afford when operating over 17 miles of continuous grade of 2.3 per cent, to allow any train to leave a terminal, unless we know that the brakes have the proper adjustment of the piston travel; that we have no leaks that will tend to cause sticking of the brakes going up hill or that will be likely to cause any failure of brakes when going down hill which might result in an accident.

In regard to the present couplers not being elastic enough, it seems to me that the Baltimore & Ohio has curvature and gradient conditions that will thoroughly test almost any coupling apparatus, and we feel that when we can get something that will meet our requirements satisfactorily, it will pretty nearly go up against anything else, where the conditions are not so severe. We regret that we have such conditions, but that is the case.

Now, in regard to the claims, it must be stated that our claims for damaged freight, and also our charges for freight car repairs, have increased with the inauguration of these hump yards and the automatic coupler. That is undoubtedly the case, with the exception of the steel cars, and it is mainly due to the fact that we have mixed in the different yards to-day cars of 40,000, 60,000 and 80,000 pounds capacity of wooden construction, and cars of 80,000 and 100,000 pounds capacity of steel construction. The steel cars have the draught gear attachments and coupling mechanism of modern type in line with the centres of the sills, and are able to cope with the conditions, but the wooden cars have not, and for that reason, we get the wooden cars sandwiched in between a lot of steel cars of heavier capacity, and the wooden cars must stand the damage.

**Mr. Dugald Drummond.** — Can you give us anything like the approximate cost for claims for damage to goods in transit?

**Mr. J. E. Muhlfeld.** — No, sir, but I could get that and send it to you.

**Mr. Dugald Drummond.** — I heard it was very heavy.

**Mr. J. E. Muhlfeld.** — I think that has been largely due to the inauguration of these hump yards. When you first put a hump yard into use, the men are not acquainted with the operation of it, and we have a great deal of damage to cars and also to freight, but after the men become acquainted with the operation of these yards, and the hump is elevated to the proper degree for both the winter service and the summer service, the claims are reduced very materially. Besides, the instructions now are to have switchmen ride these cars from the time they leave the hump until the speed is reduced to such an extent as not to cause damage. We anticipate that our freight claims will fall after the use of the hump yards is more general.

**Mr. F. G. Wright.** — I am very much obliged for the reply that I had from Mr. McIntosh. I was not aware that there was so much space between the two cars arranged as they are in America with the central coupling, and I think myself we have rather run off the road, because the Americans have never adopted and never used the method that we have at the present time in England. Before they adopted the central coupling, they had, as I understand, dead buffers and the link and pin coupling, which, of course, is a very difficult coupling to manipulate. I thoroughly endorse everything that Mr. Muhlfeld has said, and I have a few questions I should like to ask. Now, on the Great Western of England, we have had no experience at all with automatic couplings, but we have had several sent to us to experiment with, and I believe that the whole of the railway companies of Great Britain are now looking out for a thoroughly reliable automatic coupling, and in my judgment, an automatic coupling will be of no use until it entirely prevents the necessity for any human being to go between vehicles, either for coupling brake pipes, steam pipes or any other communication that may be required between vehicles, and until that is done, I do not think an automatic coupling will be thoroughly satisfactory.

Now, Mr. Muhlfeld has told us that after a train is formed it couples itself up automatically, but labor has to be used for coupling the train pipe, and then a delay takes place while you are testing the brakes. Under the system that we adopt, automatic couplings would be of no use whatever, because during the time that you are either coupling up the pipe or testing the brake, you can couple the train twenty times over. The automatic vacuum brake that we are using on some of our goods trains, necessitates the man going between the vehicles after they have been coupled with the ordinary shunting pole, but we have no delay such as you have here with the air brakes, and perhaps it is only one of the advantages I know of the automatic vacuum brake, that as soon as the whole of the vehicles are coupled together, the engineman can test the brake, and in the course of a few seconds or minutes he knows whether the brake is in fit condition for the train to travel, and of course the train moves off.

In many of the shunting yards in England we have not space enough in which to sort and divide the trains. You will find these trains being shunted in yards where the vehicles have to be taken out the second time to couple them in trains in the condition they are required to be. Therefore, automatic coupling would be a disadvantage in many cases, because you would have to uncouple the vehicles after they had coupled themselves. I should like, in the first place, to ask the American engineers whether they were able to run vehicles of the same length they do to-day before they adopted the automatic coupling, because it seems to me that one of the great advantages of the American coupling is that they are able to go round very sharp curves at a very high rate of speed. There is no doubt that the impact caused by an engine backing on to the train is very much greater than it is with our system, because I had a practical experience only last Monday when I was riding with Mr. Muhlfield in his saloon. The engine backed to the train, certainly not very hard, but it began to move the contents of the coach in which we were riding, which would not have happened if the engine had come back with twice the speed on an English coach equipped with side buffers and the large buffer spring we use.

Then, with regard to the question of claims — I am not a traffic officer myself — but I do believe that claims have increased over the whole of the railway systems of the world, and it is due in a very large measure to the utter indifference and carelessness of the staff that has to deal with the shunting. Time after time we have had machines sent from various makers, and they have come to us damaged, and it was only a few weeks before I came here that we had sent over to us three or four vehicles manufactured in America, of your pressed car design, for trial, and the first vehicle we sent to take its chance on an English train was, I think, one of your 50-ton coal wagons, and, before it got to Birmingham, four out of the eight axle-boxes were cracked, which must have been caused by a rough shunt. So it shows that whatever damage you are having in America owing to your central coupling, we are having a similar trouble owing to the carelessness of the staff who handle the vehicles. The central coupling, of course, has very many advantages, but until you are able to start the train away at once after the couplings are connected, there is not so very much advantage in the automatic coupling, and certainly there is no advantage in it unless you are able to couple both the couplings and the whole of the connections between the vehicles automatically at the same time, and thus prevent any of the staff going between the vehicles. What happens so many times in England, happened only a few weeks ago. There is perhaps a few inches of space between the buffers of two trucks, sometimes 1 foot, or sometimes 18 inches, and a man carelessly, without looking to see whether they are shunting or whether there is an engine at the other end of the train, passed between, and in this particular case when he was passing out the cars closed up and he was instantly killed. I take it that exactly the same thing would have happened in America if two of your vehicles were standing with 1 foot between the automatic couplings and a man carelessly passed through without seeing whether

there was an engine at the other end or not, or whether shunting was going on. So that there is very little to be gained in the question of safety whether you have an automatic coupling or whether you have our system, as long as the men will pass between the vehicles when they are standing with only a short space between them. But there is this advantage in our system, that if you are shunting on a curve and a man is standing between the vehicles he knows perfectly well that he is absolutely safe, but I venture to think that with your central coupling if you are shunting on a sharp curve and a man happens to be on the inside of the curve, the chances of his life must be very remote; and I should like to ask whether there are any cases where the automatic coupling refuses to act when you are standing on a sharp curve. We have had some experience with the Barnum & Bailey equipment in travelling through England, and we know the trouble we have had when they have required a train to be shunted to suit the length of sidings we have been able to place at their disposal. It may, of course, be owing to the ignorance of our staff as to how to handle vehicles fitted with automatic couplings, but I venture to think that our sidings laid out on sharp curves can be dealt with easier with our present system of coupling than with the automatic coupling, and I should like to know whether there are any cases where the coupling absolutely refuses to act when standing on sharp curves.

**The President.** (In French.) — Gentlemen, before going any further, let me remind you that it is getting late and that for some time past we have been discussing details which, though exceedingly interesting in themselves, deviate a little from the subject under discussion.

A debate like this might lead us far afield, and occupy much time. After Mr. Wright's question has been answered I suggest that we consider what conclusions are to be drawn from the discussion.

**Mr. J. E. Muhlfeld.** — In reply to that question I can say that where sufficient lateral movement has not been provided at the end sills of cars in connection with automatic couplers, there have been failures of those couplers to act on sharp curves, and it has been necessary to couple to the cars with safety chains, pull them out on straighter track and then couple, but with the method of the application of those couplers at the present time, they are coupled up in the curvatures that we make use of in connection with modern railroad construction around the terminals. With regard to the clearance between platforms, it is necessary to have clearance for curvature, and as most cars in classification yards are switched on straight tracks, we have not only the clearance that is produced by the length of the coupler heads after they are in contact, but also the clearance that is given to permit the cars to traverse the greatest amount of curvature in commercial yards, and we have some curves of 60-foot radius.

Mr. Wright made another remark relative to the handling of the same length of trains that we handle to-day, with the old method of coupling. We to-day handle

trains of 125 cars in length and with the old link and pin coupling, we would not have been able to handle those trains with the amount of slack that naturally results from that method of coupling without a large number of break-in-twos; in fact, where we are handling trains of 125 cars with a locomotive developing a tractive power from 40,000 to 80,000 pounds it would not be proper to expect that the old method of coupling would keep the train intact, especially when making stops and the slack runs out.

**Mr. F. G. Wright.** — There was one question, Mr. President, I forgot to ask just now. Is it a fact that they are introducing safety chains in view of the failures of the automatic couplings?

**Mr. J. E. Muhlfeld.** — In regard to the safety chains, we had those on passenger cars before we went to the automatic couplers, and we think it is an additional safety device that ought to be used. It does not cost any more money. They were there when the automatic coupler was applied and they have been continued. On freight cars we now apply safety chains on the class of equipment that is used for the handling of double and twin loading, that is, where you use two or three cars on which to load structural steel material, and those safety chains we regard as more economical than the use of independent chains which must be used when we load cars in that manner. We cannot depend on the coupler and draft attachments alone where we have loads of that kind, without the use of chains, and the safety chains are now being applied direct to cars of the class that are used for that class of lading, instead of depending on the use of independent chains, which are much more expensive and become lost and misplaced at terminals.

**The President.** (In French.) — If no one has any further observations to make, I now propose that the suggested conclusions should be read. You will see whether they need be altered or can be accepted as they are.

The following are the conclusions :

“ The Congress acknowledges that automatic couplings are universally used in the United States. The first types of those couplings put in service have been successively improved until very recently. However, it is remarked that the automatic coupling of air brakes and steam heating is only in an experimental stage as yet.

“ In other countries than America, several systems of automatic coupling, either of the American type or other types, have been tried. The necessity for keeping the old coupling in use and ensuring its operation during the transition period is a source of great difficulty. In favour of the American type, several engineers are of opinion that its great strength is a very desirable feature, especially when cars of large capacity are used, but other engineers would prefer the systems which can be applied to existing cars more easily and with a shorter period of transition.

“ The British engineers as a rule think that the system used in the Great Britain

and Ireland gives satisfaction as well as regards rapidity of coupling and uncoupling, and as regards the safety of men.

“ As regards the security of the employees who make the coupling and uncoupling of cars, no statistics in Europe seem to prove that this operation is more particularly dangerous with the actual European system. On the contrary, data prepared by the Northern Railway Company of France show that under the conditions existing in their lines, the number of personal injuries is very small, and that the actual European system is in no way inferior in that respect to the American system. ”

**Mr. Noltein, reporter.** (In French.) — The service conditions in European stations are quite different from those of American stations. The shunting work in America is extremely rough. It is done quickly and it is not possible to institute statistical comparisons in this respect.

We should therefore be wiser in omitting these particulars in our conclusions.

**Mr. R. Fane-de Salis.** — I should like to suggest, in the paragraph dealing with the English statement, that it should not read “ English engineers,” but “ English representatives,” and I could not quite catch the wording, but that some such word as “ at present ” should be introduced. We do not wish, I think, to suggest that we are hostile to automatic couplings, but that at present we think no coupling has been produced which promises to supersede our hook and eye coupling with favourable results. I am not quite sure whether those words were in the resolution or not as read.

**The President.** (In French.) — We might say “ the British representatives think that the system used in England is at present satisfactory as regards rapidity of handling, as well as the safety of the employees. ”

With reference to Mr. Noltein's remark as regards statistics, I presume the Northern of France company's representative, who supplied us with the figures, will say a word in reply to Mr. Noltein.

**Mr. Asselin.** (In French.) — I do not quite understand what Mr. Noltein wishes. Does he want the suggested conclusion cut out altogether, or does he desire it to be attributed specially to the Northern Company?

**Mr. Noltein.** (In French.) — I propose that the conclusion be eliminated entirely.

**The President.** (In French.) — In order to meet Mr. Noltein's views, we might perhaps eliminate the comparison with the American system, so as not to compare two things which are really not comparable.

**Mr. J. E. Muhlfeld.** — In the statement that the use of automatic couplers was general in the United States, I would recommend that it be changed to read “ The United States, Canada and Mexico ”. I have had considerable experience in Canada

on the Government railroads of Canada, the Grand Trunk Railway system, and am also pretty well acquainted with the Canadian Pacific system, and I think they have generally adopted the automatic couplers.

**Mr. Moffre**, French Midi Railway. (In French.) — As has been recently appropriately remarked, the subject possesses two aspects : on the one hand, the safety of the men and, on the other, technical convenience.

The first point is the more important. The only argument upon which the adoption or non-adoption of automatic coupling rests is the comparison between the safety of the staff in using one system or the other. Nothing but statistics can decide that point. But the only statistics before us are those supplied by the French Northern Company. I therefore propose that we should not only retain this conclusion, but strengthen it by striking out the word " particularly " before " dangerous ".

I think that the European coupling is not particularly dangerous; it is perhaps even less dangerous than the American.

**The President**. (In French.) — On that last point there will doubtless be some difficulty in agreeing.

**Mr. Moffre**. (In French.) — Still it seems to me that it would be difficult to ignore entirely the only statistics that have been brought forward.

**Mr. Bowman Malcolm**, Midland Railway, Northern Counties Committee, Ireland. — I think the reference to statistics should remain, for the simple reason that it is very difficult to make these comparisons, because the cars in the United States are very large as compared with the cars in the United Kingdom, and having one set of figures they are valuable for future reference. If the cars are large, the units are fewer, and there are fewer movements to deal with, and fewer movements mean less liability to accident.

**Mr. F. G. Wright**. — I think, Mr. President, we want to be very careful in drawing up our conclusions, to look at this question in the right way. The Americans, as I understand, had originally a solid buffer and the link and pin coupling. It was not satisfactory, and they had to set to work to get a more satisfactory coupling. And they have done so in the most economical way. Now, we in Great Britain, and of course on the continent, have gone in for the spring buffers and the chain coupling, which up to the present time we find answers very satisfactorily, and it would be just as expensive for us to throw away all our spring buffers and go to the automatic coupling as it would be for the Americans to throw away the automatic coupling and go to the spring buffers, even assuming that our system is better than theirs or that their system is better than ours. Then, again, it would be practically impossible to run vehicles of the length they do in America with our system of couplings, so I think we want to be very careful to look at it in the proper light, so as to arrive

at the proper conclusions, and it would be very interesting if it were possible to arrive at the actual number of deaths or injuries which were actually attributable to the coupling and uncoupling of vehicles fitted with automatic couplings and those fitted with the ordinary chain couplings, and the basis should be on the standard of the number of miles run per car.

**Mr. W. McIntosh.** — I would suggest for the information of the foreign gentlemen present, that all the information required with regard to accidents to employees is available in the report of the Interstate Commerce Commission of the United States. I regret that we have not a copy here. It is easily procurable by any one who is interested.

Might I ask you, M. President, to read the conclusions so far as they relate to the practice in the United States.

**The President.** (In French.) — Mr. McIntosh says that the statistics concerning America appear in the Interstate Commerce Commission's Report. Unfortunately we have no equally full statistics in Europe on this subject.

As regards the safety of the men whose business it is to couple and uncouple vehicles, statistics fail to prove that these operations are particularly dangerous with the system employed in Europe.

The final paragraph of the conclusions runs as follows : " On the contrary, data prepared by the Northern Railway Company of France show that under the conditions existing on their lines, the number of personal injuries is very small. "

It would perhaps be well to go further and say that American statistics show that an improvement has taken place under the American system, but that so far there exist no European statistics supplying the data required for forming a sound judgment with regard to methods of coupling. So far as can be judged, the European system does not, however, involve serious risks.

**Mr. Laurent.** (In French.) — It seems to me that the question of retaining the statistics supplied by the French Northern Company in the section's conclusions, ought to be decided in the affirmative. Mr. Asselin's statistics do not mean that the service is better carried out on the European railways. They only show that the traffic conditions are different on American railways, that these different conditions arise from the heaviness of the traffic or from a difference of rolling stock. It may therefore be true that the question of automatic couplings does not arise in Europe as it does in America, and from this standpoint, the suggested conclusion is satisfactory to everyone. It merely affirms two facts ; in America, automatic coupling has caused a certain number of accidents ; in Europe, there are comparatively few accidents due to the system of coupling employed.

Here we have two facts which it is well to bring face to face and they are brought together in Mr. Asselin's statistics. I am, therefore, in favour of retaining the conclusion that has been suggested.

**The President.** (In French.) — I shall take the opinion of the meeting with regard to the conclusions after subdividing them into two portions. One portion of the conclusions has been accepted with trifling alterations. The section agrees that automatic coupling has been accepted in the United States, Mexico and Canada. It affirms further that automatic coupling of brake and steam pipes is still in the experimental stage.

It is then stated that in other countries the various systems of American or other automatic couplings are still on trial, that some engineers prefer the American system owing to its great strength, that others, on the contrary, would prefer a system which could be substituted with greater rapidity. Lastly it is stated that British representatives find their system quite satisfactory.

On these various points, the meeting seems to me to agree; I therefore put this portion of the conclusions to the vote, leaving on one side the second part of the conclusions about which there are doubts.

**Mr. F. G. Wright.** — If you discuss the question of statistics afterwards, it will be obviously unfair to make a comparison between one country and the United States, because this is an international conference, and you could only compare two systems. If you compare the system in the United States with the systems adopted in other countries, the comparison will be quite fair and clear. I think it will be unfair to compare any railway in France with a system in operation in the United States or in America as a whole.

**The President.** (In French.) — I think the conclusion I was proposing will satisfy the wish just expressed, because there is no connection between the two paragraphs I was submitting to the meeting. The first paragraph asserts that automatic coupling has been accepted through out the United States, Canada and Mexico.

**Mr. Evelyn Cecil,** London & South Western Railway. — I may say, Mr. President, I was informed, when in Canada, by a leading official of one of the largest Canadian lines, that he did not at all feel great satisfaction with regard to the trial of automatic couplers. I do not fancy that such a phrase would express his views, or that the inclusion of Canada in that resolution — if it indicates the absolute success of the couplers — would be approved by him.

**The President.** (In French.) — But it is used universally in America and we are content with saying so.

**Mr. J. E. Muhlfield.** — On that subject, I would like to say that I was employed for several years by the Grand Trunk Railway system of Canada and also by the Government Railroads of Canada, and during the time that I was employed by those companies, we continually bettered our equipment each month by making the application of a certain number of M. C. B. couplers. When I was employed in Canada by the Intercolonial and the Prince Edward Island railroads, which consti-

tute the Government Railroads of Canada, as superintendent of motive power, each month we were required to apply a certain number of M. C. B. couplers and each year Parliament would vote a certain amount of money for that purpose, although it was not necessary that the Government's cars be so equipped.

**The President.** — If no one wishes to say any more, I shall put to the vote the first part of the conclusions, reading them once again :

“ The Congress recognizes the universal use of the automatic car couplers in the United States, Canada and Mexico. While the type (M. C. B.) remains the same as first adopted, the details have been continually improved. Devices for automatically coupling the air brake, air signal and steam heat pipes are used to some extent. They are only in the experimental stage.

“ In countries other than those mentioned above, several systems of automatic car couplers, either of the American (M. C. B.) type or other types, have been tried. The necessity of working with couplers of a different type from those in use causes great difficulty during the transition stage.

“ Several representatives were in favour of the American (M. C. B.) type on account of its great strength, especially where large cars are used, while other representatives favored the use of such types of couplers as could be more readily applied to existing stock, so as to reduce the period of transition.

“ The British representatives expressed the opinion that the system used in Great Britain and Ireland is at present satisfactory as regards rapidity of handling, as well as the safety of the employees. ”

— The conclusions were adopted unanimously.

**The President.** — Here now is the second part of the conclusions :

“ With regard to the number of accidents, American statistics show that they have been considerably reduced by the general adoption of the M. C. B. type of automatic coupler. In Europe, statistics do not indicate that the operation of coupling and uncoupling is particularly dangerous with the types of couplers used at present. On the contrary, data prepared by the Northern Railway Company of France show that under the conditions existing on their lines, the number of personal injuries is very small. ”

— Adopted unanimously.

— The meeting adjourned at 4.30 p. m.

---

## DISCUSSION AT THE GENERAL MEETING

---

**Meeting held on May 13, 1905 (afternoon).**

---

**MR. STUYVESANT FISH, PRESIDENT, IN THE CHAIR.**

**GENERAL SECRETARY : MR. L. WEISSENBRUCH.**

**ASSOCIATE GENERAL SECRETARY : MR. W. F. ALLEN.**

**The President read the**

### **Report of the 2<sup>nd</sup> section.**

(See the *Daily Journal of the session*, No. 9, p. 187.)

“ Mr. A. W. GIBBS requested permission to omit the reading of his report, because the question of automatic drawgear never arises in the United States, where automatic coupling is universally employed under conditions precisely defined by legislation and by the rules of the Master Car Builders' Association. Only questions of detail remain, such as the uniformity of types, and strength of couplers and coupling on curves. This last point is the chief one, for since the introduction of steel the tensile strength, at all events, is more than sufficient. In this connection, Mr. A. W. Gibbs cited some experiments since his report was written; the tensile strength of the weakest coupler, of a style already out of date, was found to be 104,000 pounds; that of more modern types varies between 200,000 and 300,000 pounds.

“ Other countries are in a different position, for the question of adopting or not adopting automatic couplers may arise there, as well as that of the type of coupler to be chosen.

“ One of the secretaries then read the conclusions from the report of Mr. W. F. PETTIGREW (*Furness Railway*).

“ Mr. G. NOLTEIN then read an abstract from his report.

“ He stated that the application of automatic couplers in Europe usually has the twofold object : first, of preventing accidents in switching, and then of securing

a considerable increase of tensile strength. In practice, the solution of this twofold problem has only been obtained up to the present time by the American type, well known under the name of the Master Car Builders' coupler, but, unfortunately, the application of this ingenious device involves a considerable increase of dead weight, which is all the more disadvantageous because the capacity of the cars is less. For an ordinary European car with 10 to 15 tons' capacity, the increase in dead weight arising from the adoption of two M. C. B. automatic couplers amounts to about 1,785 pounds, involving quite a heavy expense. This fact alone is sufficient to explain the opinion shared by most engineers in France, England, Russia and other European countries, that the general application of the M. C. B. coupler on existing rolling stock would be a ruinous measure for railway companies.

" The subject, however, assumes a different aspect where the capacity of the cars and the effective carrying capacity of freight trains are to be increased in a high degree.

" The reporter, after the investigations made in Germany on this subject, related the experiments made by the Moscow-Kasan Railway. This company, having recognized the absolute necessity of strengthening the couplers for the purpose of gradually increasing the carrying capacity of their trains to 1,000 tons, began investigating the subject in 1898. The result of these investigations was the construction of box cars with a capacity of 27 metric tons (26.6 English tons), equipped with an automatic coupler which is described in detail in the report and which gives satisfaction.

" As regards passenger cars, the subject of automatic drawgear has also been investigated by the reporter, who has applied to the new cars of the Moscow-Kasan Railway a coupler of the American system combined with the equipment described in his report under the name of " equipment with spring vestibules. "

" Mr. Nolte's conclusions were as follows :

" 1° In the case of passenger carriages, the question of the application of American couplers seems to be easier to solve, as their number is much smaller than that of goods wagons, and the service is much more regular.

" 2° The transition systems examined for goods wagons are equally suitable for passenger carriages. But any arrangement with considerable overhang is not to be recommended, for the reasons explained in the report.

" 3° In the case of new carriages, equipment with spring vestibules offers essential advantages from the point of view of safety. It makes the cars run more smoothly, it counteracts any shocks due to badly adjusted continuous brakes and offers certain guarantees in case of accident. "

" At the request of the PRESIDENT, Mr. A. W. GIBBS added some words regarding the difficulties experienced during the period of replacing the primitive link and pin coupler with the automatic coupler. Quite a number of accidents took place during this period. Experience has demonstrated the superiority of the position of the

automatic coupler on the neutral plane of the underframe. A difficulty which has not yet been entirely overcome is that on the tracks of bridges leading from the bank to the "car floats," the couplers form at times such an acute vertical angle that they bend and the buffer beams of the cars undergo excessive strains.

" Mr. J. E. MUHLFELD (*Baltimore & Ohio Railroad*) mentioned another difficulty arising from insufficient side play on sharp curves. This difficulty, however, is not usually encountered on main lines, provided the centre of the bogie is sufficiently near the end of the car, when the drawgear has about 1 inch side play each way.

" Replying to a question put by Mr. SABOURET (*French Western Railway*) regarding the frequency of accidental uncoupling, Mr. J. E. MUHLFELD said that, with many of the old types, the cars were quite easily uncoupled in the case of a somewhat violent shock. With the present couplers, the lock is movable vertically, and when it reaches the end of its travel, the surfaces of friction are sufficient to prevent it from lifting. Still, in coupling locomotives, there is a risk of having the lock spring out, when operating double headers on curves or running into sidings. It is desirable to secure it with a spring, as in the case of passenger car couplers.

" Mr. F. PETRI (*German Government*) gave some information on the subject of experiments made in Germany with automatic drawgear of the American type. These experiments were based on the recognized need of strengthening the present type of drawgear and avoiding accidents in coupling. The investigations bore chiefly on two points: the arrangements to be adopted during the transition period and the modifications which should eventually be made in American couplers, chiefly from the standpoint of the section. The tendency in Germany is to close the coupler hook more, as has already been done by the Master Car Builders' Association in 1904. Another point to be cleared up is the height at which the new coupler should be placed. The German Railway Association has decided to engage in experiments on a large scale on the subject.

" German engineers are following with great interest the improvements which are being made in America in the interior mechanism of coupler heads. They take an equally keen interest in experiments made in other countries with other types of automatic drawgear, especially the tests made in France with the Boirault apparatus.

" Mr. BOELL (*French State Railways*) gave some information concerning this latter device, which has been adopted on ten cars of the French State Railways. The Boirault drawgear was designed with a view to making no change in the construction of European cars, avoiding the increase in weights and prices involved in other systems of automatic couplers (the increase in price being in some cases as high as 1,500 francs [£60] per car), and greatly accelerating the transformation.

" Mr. Boell then gave the description of the apparatus, as published in the *Organ für die Fortschritte des Eisenbahnwesens* and in the *Revue technique*. A model of this coupler is on view at the Liège Exposition.

“ The trials made with this drawgear during more than two years on 20-ton cars have been most satisfactory; no accident or failure has occurred under the most severe conditions. Furthermore, a circular letter from the ministry has just invited all the railway companies in France to make a trial of these appliances.

“ The weight of a complete coupler head of this system is 60 to 80 kilograms (132 to 176 pounds).

“ To a remark made by Mr. SARRE (*German Government*), who has followed the experiments made with the Boirault coupler at Tempelhof, and had the impression that, in its present form, this apparatus is not sufficiently strong, Mr. BOELL replied that its strength could easily be increased without greatly increasing its weight, and that in any event this weight would be considerably less than that of American couplers.

“ Mr. BRISSE (*French Eastern Railway*) observed that in Europe the matter is of international importance; the continual transfers of rolling stock between the different countries of Europe — Russia and Spain excepted — call for the adoption of a single standard. To lessen the difficulties of the transition stage, he thought it necessary to select the solution which would make this period shortest, by adopting a device, the frame of which can be prepared in advance and go into service on a stated day.

“ Mr. LAURENT (*Orleans Railway*) declared that however interesting the Boirault device may be, the trials made on the French State Railways have been on too small a scale to be conclusive. The Orleans Company purposes to make a more thorough trial, with the view of deciding whether the various advantages accruing from its use, if successful, warrant introducing it. The Boirault drawgear has the advantage of adapting itself to the existing drawgear, and it does not seem necessary to resort to the American coupler in order to obtain sufficiently powerful drawgear. The latest couplers put into service in France, resist a pull of 55,000 kilograms (121,200 lb.), it is evident that the Boirault coupler must resist the same pull. Mr. Laurent also stated that conditions in America are not the same as in Europe, where the number of accidents due to couplers is lower than in the United States even at the present time. Hence, the very principle of adopting automatic coupling on European railways is open to discussion, in view of the difficulty and expenses of installing the system.

“ Mr. F. BALTZER (*German Government*) and Mr. PETRI emphasized the fact that tests, to be conclusive, must be made upon a large scale, and they hoped that the present meeting of the Congress would result in leading a large number of railway managers to make such tests. The latter gentleman added that the extensive experiments already made in Germany with American automatic drawgear have been very favourable to this type of coupler.

“ Mr. R. FANE-DE-SALIS (*North Staffordshire Railway, England*) reported that two trains equipped with American couplers have been running on his line for the last three years. These couplers do not appear to him as reliable or as quick acting as the common coupler. A special difficulty in England is the large number of cars belonging to private individuals.

“ THE PRESIDENT stated that the subject naturally divides itself into two branches. First of all, there is the question of the technical details of the automatic coupler, its tensile strength and the ease with which it can be operated, etc. The second branch of the question deals with the security, the reliability of the automatic couplings, and that is a question which can be best solved by referring to the statistics of accidents.

“ Mr. ASSELIN (*French Northern Railway*) said that the accidents of which the employees are the victims in their work merit the most serious attention on the part of railway managers. It is a question of humanity and of professional duty. As to the French Northern, efforts have been made for several years to safeguard this work, and the matter has been given special attention, not only to ascertain the number of accidents of every kind, but to determine the precise cause of such accidents. Owing to rules being strictly observed and to proper supervision, the number of accidents to the men employed in 1903 was reduced to 921, but it should be remarked that this includes the smallest accidents, including a great number of very insignificant account. Of this number (921), 45 were fatal, and the number fell in 1904 to 762, of which 32 were fatal, a diminution of 18 per cent as compared with the figures of 1903. As to the number of accidents in the operations of coupling and uncoupling, taking up one by one the reports of accidents since 1898, Mr. Asselin finds 29 accidents in 1903, of which two were fatal, and 20 accidents in 1904. There was only a mean of three fatal accidents per annum during that time. This shows that the number of accidents which are due to coupling and uncoupling the vehicles amount only to about 4 per cent of the whole, and that 96 per cent of the accidents are due to other causes. These should be dealt with as much as possible, so as to diminish them. In addition, these results have been compared with those which have been obtained from the American records. It has been shown that upon the Northern Railway of France there was a mean per annum of 27 accidents, of which about three, exactly 2.6, were fatal, per annum. This would make for 100,000 persons 37 accidents, of which 5.5 were fatal. In America the official reports, by the consular agents, show that there were 243 accidents, of which 16 were fatal. The records of the French Northern Railway for 100,000 were far below that figure, with the double buffer arrangement and a coupling of the non-automatic type, and it is easily understood how much this company hesitates to take up an unknown arrangement which seems to have so little to recommend it, as shown by the American records.

“ There is, however, another point in this matter. The French Northern Rail-

way Company has direct connections with other lines and exchanges cars with those of the whole of Continental Europe, with the exception of Russia and Spain, which have tracks of a wider gauge. The period of transition, which has not been less than seven years in America, is particularly important from the point of view of the safety of the persons employed. How many human lives would be sacrificed during this period of transition, and how many would be saved afterward, is the question.

“ Mr. William McIntosh (*Central Railroad of New Jersey*) said that the old link and pin couplings required careful handling of the cars in order to allow the switchmen or brakemen to make the connections. Since the introduction of automatic couplers but little attention is given to careful handling of the cars, the result being that it was found necessary to strengthen the sills and parts of the cars to which the couplers are attached. Cars are handled now very carelessly, and the introduction of the automatic features on European lines will bring about the same condition of affairs. During the past ten years, there has been practically a revolution in the weight of equipment. They had during this period increased the capacity of the cars to 60,000 and 80,000 and 100,000 pounds. This has called for much stronger couplers, and they are now using steel almost exclusively, and the parts are made larger than formerly. Naturally, with many of the cars of small capacity still in service with the lighter couplers there have been failures. But notwithstanding this, there has been a very evident diminution in the number of failures, until at the present time, it is an unusual occurrence to have a failure of any kind with the couplers in passenger equipment. The failures in freight service are decreasing rapidly, and are more attributable to carelessness in handling the cars in shunting, than to any strains that occur in the natural movement of the cars over the line.

“ Mr. J. E. Muhlfield said that the tonnage handled in the United States during the past ten years has almost doubled in freight service, and there has been a large increase in the number of passengers carried and trains moved. In comparison with the yearly records of personal injuries, this would indicate that there has been a decided advantage through the use of the M. C. B. type of coupler. The first couplers put in service were of malleable iron, and the design was such as would permit of the opening and closing of the knuckle only. The couplers now in use are of cast steel and they are designed so as to admit of several operating features that are necessary for the present requirements.

“ Now, with regard to the points that Mr. Petri brought out relative to the contour of the knuckle, the contour that was adopted last year, the M. C. B. contour, is better than the previous one. The knuckles before were made rather flat instead of raised, in order to give a good bearing. As this part of the knuckle wore away, especially during rainy weather and on heavy trains, the knuckles would tend to slip past each other on straight track.

“ Of course an M. C. B. design of coupler for a car of 20 tons capacity can be made

very much lighter than the coupler such as we use for a car of 100,000 pounds capacity, which must be designed so that they can be switched over hump yards and at the same time connect them automatically. The very fact that the switchmen are now not required to go between cars to effect couplings should confirm the fact that there must be less liability to injury. The old method of coupling necessitated a man going between the cars, whereas with the present coupling that is not done. It is not practised at all. While in a great many cases we like brakemen to ride cars in yards where they are coupled, and see that the impact is not severe, or too great, so as to result in damage, yet that is not the general rule, and the cars are switched over humps of considerable gradient and left to go down into the yard and the impact is depended upon to couple the cars in trains.

“ Lieutenant-colonel H. A. YORKE (*British Government*) said he appeared before the meeting as a student and not as an instructor. In England, there are two problems at the present time which are engaging a great deal of attention. One is that of automatic coupling. The introduction of an automatic coupling suitable for freight stock is of great importance. The other is the building of freight stock with the automatic continuous brake. Those questions seem to be very intimately connected. The object of an automatic coupling is principally to prevent the necessity of the railway employees going between the wagons in order to couple them together. In England at the present time, it has been rendered unnecessary for men to go between the wagons to couple them together, by the use of the coupling stick, which is an article of every day use throughout the railways of England. But it is no use to render it unnecessary for a man to go between the wagons to couple them together if he subsequently has to go between to couple the brake pipes together; and he would like to know what the experience in America has been as regards the automatic coupling of brake pipes.

“ Mr. J. E. MUHLFELD agreed with Colonel Yorke that the application of the automatic coupler is mainly to prevent personal injury to employees. Another reason is to facilitate the switching and handling of cars at terminals, and especially at classification yards. Now, the method for coupling cars together is entirely different from the method of coupling the brake and signal and steam pipes. When cars are coupled together either both or one of the cars are moving, in some cases in gravity yards both cars are moving when they are coupled. When it comes to the coupling of the air hose, that is done after all the cars have stopped motion. There is no movement of any of the cars. The car inspectors and the men that inspect the brake apparatus, adjust the travel of the brake cylinders, etc.

“ Mr. William McINTOSH stated that there is a small division of the New York Central where passenger trains are operated with a self-coupling device for air and steam, and the Long Island Railroad is operating a number of trains successfully with the same device, which is of Westinghouse manufacture.

“ Mr. SABOURET made some remarks on the essential differences between the American and European couplers.

“ Mr. A. W. GIBBS, reporter, stated that in former times side buffers without springs were very generally used in American cars, because the coupler then used was not adapted to resist the impact. These side buffers were generally known all over America as “ man-killers ”.

“ Mr. William McINTOSH corroborated Mr. Gibbs' claims in that connection and added that if a man stands between cars of the American type, on either side of the coupler, when they come together, there is still room enough on either side to allow him to stand without injury.

“ Lieutenant-colonel H. A. YORKE made some remarks on the time consumed in America for coupling the hose and testing the air brake and Mr. J. E. MUHLFELD gave him some information as to the way of doing these operations.

“ Mr. Dugald DRUMMOND (*London & South Western Railway*) said that in Great Britain and Ireland, the railways possess something like 2,193,000 vehicles, so that any departure from the present arrangements now on those railways as to coupling up would be a very serious matter, unless something better than that already possessed can be assured. So far as the speaker could see, the couplings used in America would not serve as well as those already in use in England. He should like, therefore, to know what the experience in America has been in the damage to goods in transit with the mode of marshalling which has been adopted.

“ Mr. J. E. MUHLFELD replied that the claims for damaged freight, and the charges for freight car repairs have increased with the inauguration of the automatic coupler. That is undoubtedly the case, with the exception of steel cars, and it is mainly due to the fact that there are mingled in the different yards to-day cars of 40,000 pounds capacity, 60,000 and 80,000 pounds capacity, of wooden construction, and cars of 80,000 and 100,000 pounds capacity of steel construction.

“ Mr. F. G. WRIGHT (*Great Western Railway, Great Britain*) thoroughly endorsed everything that Mr. J. E. Muhlfield had said, and added a few questions. On the Great Western of England, there has been no experience at all with automatic couplings, but they have had several sent to them to experiment with, and he believed that the whole of the railway companies of Great Britain are now looking out for a thoroughly reliable automatic coupling, and in his judgment an automatic coupling will be of no avail until it entirely prevents the necessity for any human being to go between vehicles, either for coupling brake pipes, steam pipes or any other communication that may be required between vehicles, and until that is done, no automatic coupling will be thoroughly satisfactory.

“ Replying to a question of Mr. F. G. WRIGHT, Mr. J. E. MUHLFELD stated that

safety chains are still used on passenger cars, and on freight cars only where two or three cars are used on which to load structural steel material.

" After a discussion, in which Messrs. R. FANE-DE-SALIS, NOLTEIN, J. E. MUHLFELD, BOWMAN MALCOLM (*Midland Railway, Northern Counties Committee, Ireland*), F. G. WRIGHT, William McINTOSH, LAURENT and Evelyn CECIL (*London & South Western Railway*) took part, the following conclusions were unanimously approved. "

**The President.** — The following are the

#### DRAFT CONCLUSIONS.

" The Congress recognizes the universal use of the automatic car couplers in the United States, Canada and Mexico. While the type (M. C. B.) remains the same as first adopted, the details have been continually improved. Devices for automatically coupling the air brake, air signal and steam heat pipes are used to some extent. They are only in the experimental stage.

" In countries other than those mentioned above, several systems of automatic car couplers, either of the American (M. C. B.) type or other types, have been tried. The necessity of working with couplers of a different type from those in use causes great difficulty during the transition stage.

" Several representatives were in favor of the American (M. C. B.) type on account of its great strength, especially where large cars are used, while other representatives favored the use of such types of couplers as could be more readily applied to existing stock, so as to reduce the period of transition.

" The British representatives expressed the opinion that the system used in Great Britain and Ireland is at present satisfactory as regards rapidity of handling, as well as the safety of the employees.

" With regard to the number of accidents, American statistics show that they have been considerably reduced by the general adoption of the M. C. B. type of automatic coupler. In Europe, statistics do not indicate that the operation of coupling and uncoupling is particularly dangerous with the types of couplers used at present. On the contrary, data prepared by the Northern Railway Company of France show that under the conditions existing on their lines, the number of personal injuries is very small. "

**The President.** — Are there any objections ?

**Mr. Piéron**, French Northern Railway. (In French.) — Is there anything against leaving out the word " particularly " in the last paragraph ? It would seem to me that the operations in question are a little dangerous and that might be implying a weight of responsibility upon the many companies which use side buffers and the coupling which is, up to a certain point, the European standard coupling.

**Mr. Sauvage**, *president of the 2<sup>nd</sup> section*. (In French.) — The section thought that these operations did not involve any more risk than all the operations required in working a line. There must always be a certain percentage of risk in every industry.

Contrary to accepted views, coupling operations do not seem to involve any special risk — that is to say their co-efficient of safety is fairly high. This is what the section meant and it was the result of a long and thorough discussion.

**Mr. Piéron**. (In French.) — The main idea of the conclusions would not be affected by cutting out this word.

**Mr. Noltein**, *reporter*. — No one who has watched European cars being coupled together can approve of the proposed omission of the word “particularly”. There is still danger in that operation and nobody can deny that. There may be not much danger under conditions prevailing in France and Belgium, but there is the more danger in Sweden, Norway and Russia, especially in winter, when trains are under snow and ice.

**Mr. Laurent**, *Orleans Railway, France*. (In French.) — I was present at the discussion and it was proved that the conditions of rolling stock and operation are different in Europe — at least in certain parts of Europe — from what they are in America.

In the conclusions the word “particularly” might suggest an idea which I do not think occurred to the section when it adopted the conclusions; it seemed to me that the section intended to accept a difference between America and Europe, inasmuch as the conditions of coupling and uncoupling could not be regarded as dangerous in the circumstances in which they are carried out in Europe and that, consequently, the question of automatic coupling did not possess the same importance there.

I therefore support Mr. Piéron's proposal.

Moreover, if it might be deduced from this term that there was a certain amount of danger in coupling and uncoupling, there would be contradiction between this assertion and the assertion that follows according to which statistics prove, on the contrary, that accidents in coupling and uncoupling are very few.

**Mr. von Leber**, *Austrian I. R. Ministry of Railways*. (In French.) — Could we not say that these operations are not dangerous?

**Mr. Th. N. Ely**, *Pennsylvania Railroad*. — I think that the whole of the last paragraph should be stricken out of the conclusions, as it does not seem to me that it serves any useful purpose or gives any information to railway men, and I so move you, sir. (*Applause.*)

**The President** put the question of Mr. Ely's motion and it was determined in the affirmative, whereupon the conclusions were adopted as amended.

**Mr. Lionel Marze**, French Northern Railway. (In French.) — The last paragraph contains an assertion that cannot be left out. Namely, the view of the section as to the greater or less danger of the appliance in question. We might arrive at the decision intended by the section by stating that it offers no danger of a special character; there is only the risk common to any industry.

**The President.** — I have begun counting votes and therefore the question is no longer open. (*Hear, hear.*) The votes not in favour of the motion will now be taken.

Those who are in favour of retaining the last paragraph are requested to stand up.

— It was decided to omit the last paragraph and the rest of the conclusions were adopted.

**The President.** — The following are therefore the

### CONCLUSIONS.

“ The Congress recognizes the universal use of the automatic car couplers in the United States, Canada and Mexico. While the type (M. C. B.) remains the same as first adopted, the details have been continually improved. Devices for automatically coupling the air brake, air signal and steam heat pipes are used to some extent. They are only in the experimental stage.

“ In countries other than those mentioned above, several systems of automatic car couplers, either of the American (M. C. B.) type or other types, have been tried. The necessity of working with couplers of a different type from those in use, causes great difficulty during the transition stage.

“ Several representatives were in favor of the American (M. C. B.) type on account of its great strength, especially where large cars are used, while other representatives favored the use of such types of couplers as could be more readily applied to existing stock, so as to reduce the period of transition.

“ The British representatives expressed the opinion that the system used in Great Britain and Ireland is at present satisfactory as regards rapidity of handling, as well as the safety of the employees. ”

---

# APPENDICES

---

[ 625 .216 ]

## APPENDIX I.

---

### **Addenda to report No. 1 (England),**

By WILLIAM F. PETTIGREW, M. I. C. E., M. I. M. E.,  
LOCOMOTIVE, CARRIAGE AND WAGON SUPERINTENDENT FURNESS RAILWAY.

---

Figs. 15 to 19, pp. 1311 to 1315.

---

#### **Automatic couplers.**

Since preparing the report on automatic couplers, a new automatic buffer coupler now being tried, has been brought to my notice. This is known as the Jepson coupler and is being placed on the market by the proprietors, the A. B. C. coupler, Limited.

This coupler has many points to recommend it, it is equally suitable for carriage and wagon stock, as it couples tight automatically at high or low speeds, both on the straight road and on sharp curves. It is uncoupled by the pull of a chain from either side of a vehicle, and the couplings at both ends of the vehicle are identical; it is, therefore, quite unnecessary for a man to pass between the vehicles.

The standard pattern coupler, which is illustrated by figures 15, 16 and 17, is arranged to couple automatically at 4 inches difference of level. A slot is provided in the headstock to allow lateral movement, and the draw and buffing springs are so arranged that flexibility is allowed to the couplers for traversing the sharpest curves, the arrangement being suitable for continuous or non-continuous draw gear, and it is such that when the couplers are released they automatically return to the central position.

The action of coupling is as follows : When two vehicles are shunted together, the shackle noses meet. These shackles are balanced and ride upon a fulcrum provided

in the buffer head, and the pin at the rear is placed in a vertical slot, so that the nose is capable of being elevated or depressed, and on meeting one shackle passes below the other, and up the inclined table in the buffer head until it meets the vertical part of the disc directly behind the hook, and as the shackle moves forward it causes the disc to rotate, until the buffer faces have come in contact, when the half weight of the engaging shackle, together with the added weight of the overlying one are resting upon the horizontal portion of the disc behind the hook and complete the closing operation, the disc hook being so formed that the weight of the shackles when the buffer faces come in contact, are acting on the inner side of the pin about which they turn the hook by gravity. When the hook is in the closed position, the locking bar is driven home by the action of the spring; the disc hook is thus held in the locked position until the locking bar is withdrawn for the purpose of uncoupling.

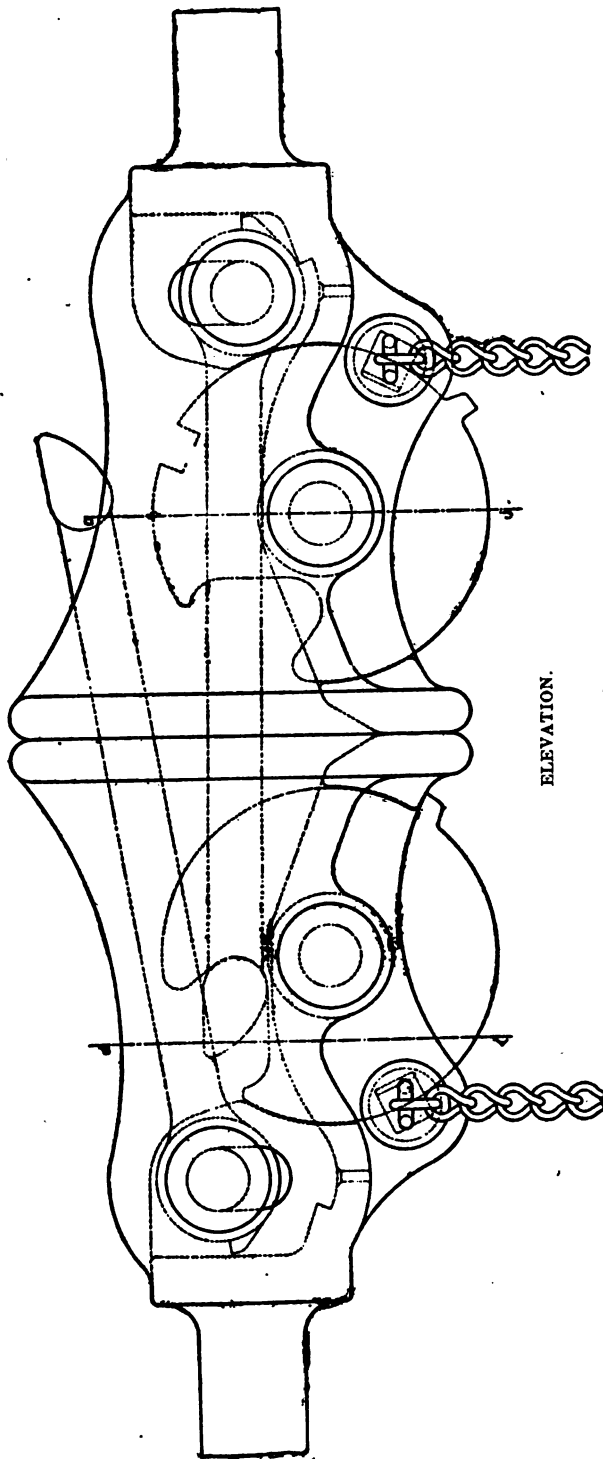
The locking bar performs a further function. When the disc hook is in the open position, it is held in that position by the spring pressing the locking bar hard against the side of the rim of the disc. The projection on the locking bar for engaging the disc hook is inclined at each end, so that when two couplers come together at a high rate of speed, the locking bar enters the keyway in the rim of the disc hook before it comes directly opposite to it, and thus ensures coupling. It should be noted that the locking bar springs have no strain upon them when the hook is in the coupled position; consequently, there is no fear of their breaking and permitting the locking bar to travel endwise and the vehicles to become separated, and it will be further observed that these springs are provided with ferrules which prevent their being over-strained and damaged. Only the lower shackle engages, the overlying one being lifted clear of the opposing disc hook by the nose of the lower shackle as it travels up the inclined table in the buffer head. Consequently, one disc hook always remains in the open or uncoupled position, and the other becomes coupled.

When the locking bar is withdrawn for the purpose of uncoupling, the disc hook is turned into the open position by the shackle of the outgoing vehicle as the two couplers separate, and it is thus left in the uncoupled position and held there by the locking bar, ready for recoupling automatically.

It will be seen from the above, that the motion of the vehicle causes the disc hook to rotate in the action of coupling and uncoupling.

It will also be noticed, that the shackles never rise above the top of the buffers; consequently, they will not interfere with the vestibules of carriages where such are provided.

It will be seen by reference to the drawings that this coupler is exceedingly simple in its construction and has very few wearing parts, and none of these are subjected to the buffing strains, the latter being passed through the solid metal of the buffer head and shank to the springs and on to the vehicle. The buffer faces are flat, and when two vehicles meet on a curve the flexible spring arrangement allows the two



ELEVATION.

Fig. 15. — The A. B. C. Jepson patent automatic buffer coupler. — Standard pattern.

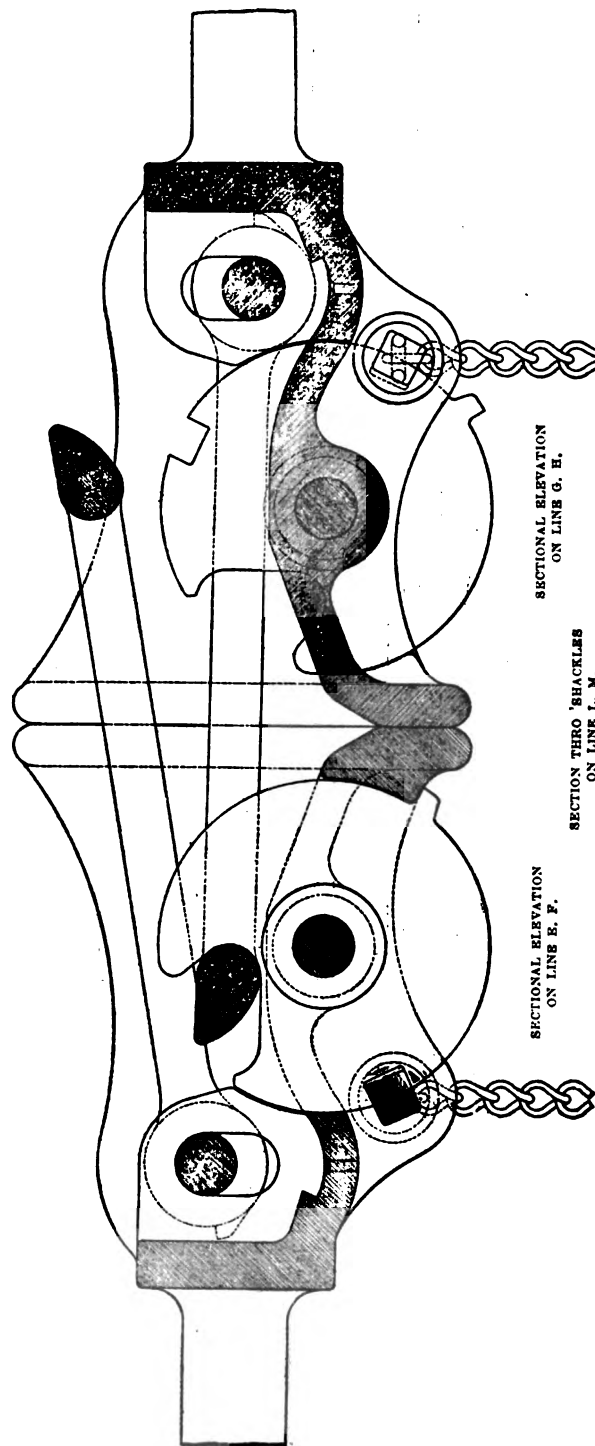


Fig. 16. — The A. B. C. Jepson patent automatic buffer coupler. — Standard pattern.

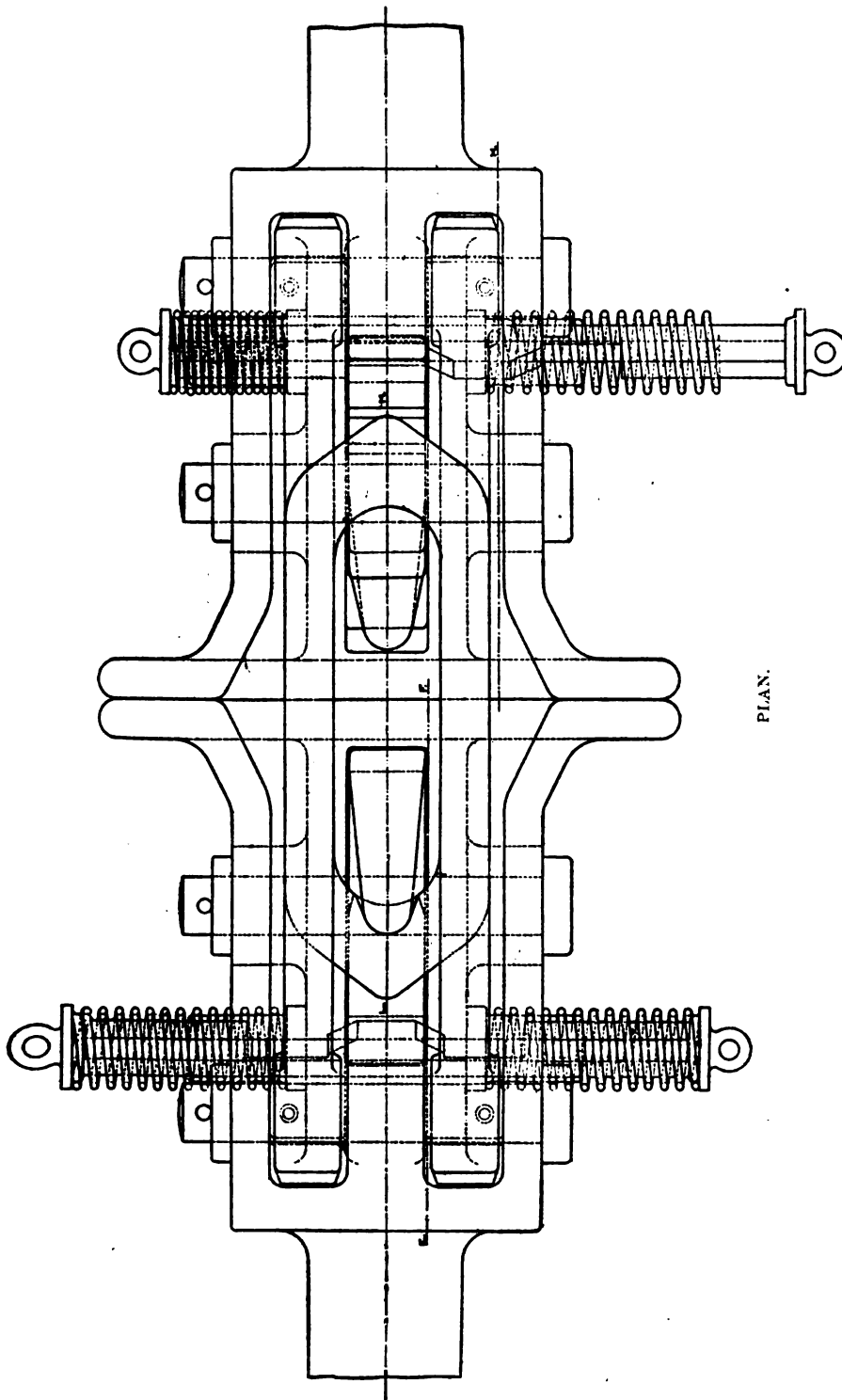


Fig. 17. — The A. B. C. Jepson patent automatic buffer coupler. — Standard pattern.

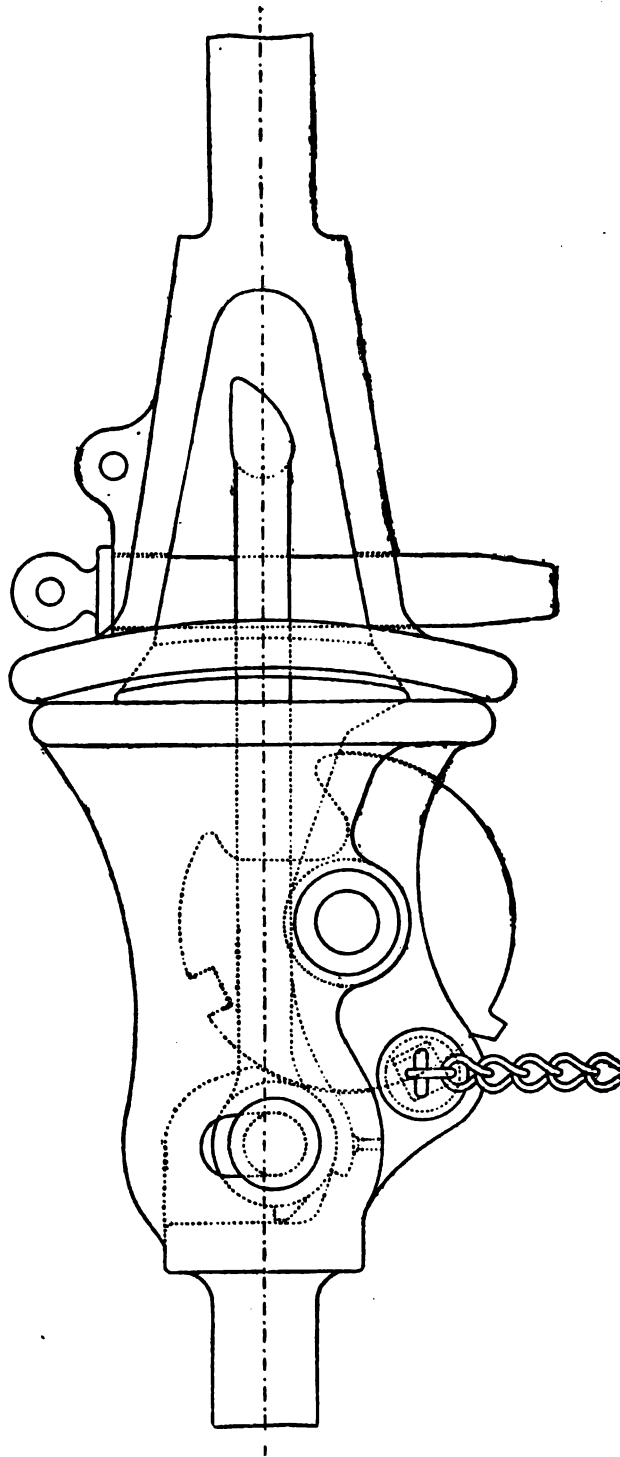


Fig. 13. — The A. B. C. Jepson patent automatic buffer coupler. — The Jepson coupler connected to the standard South African link and pin coupler.

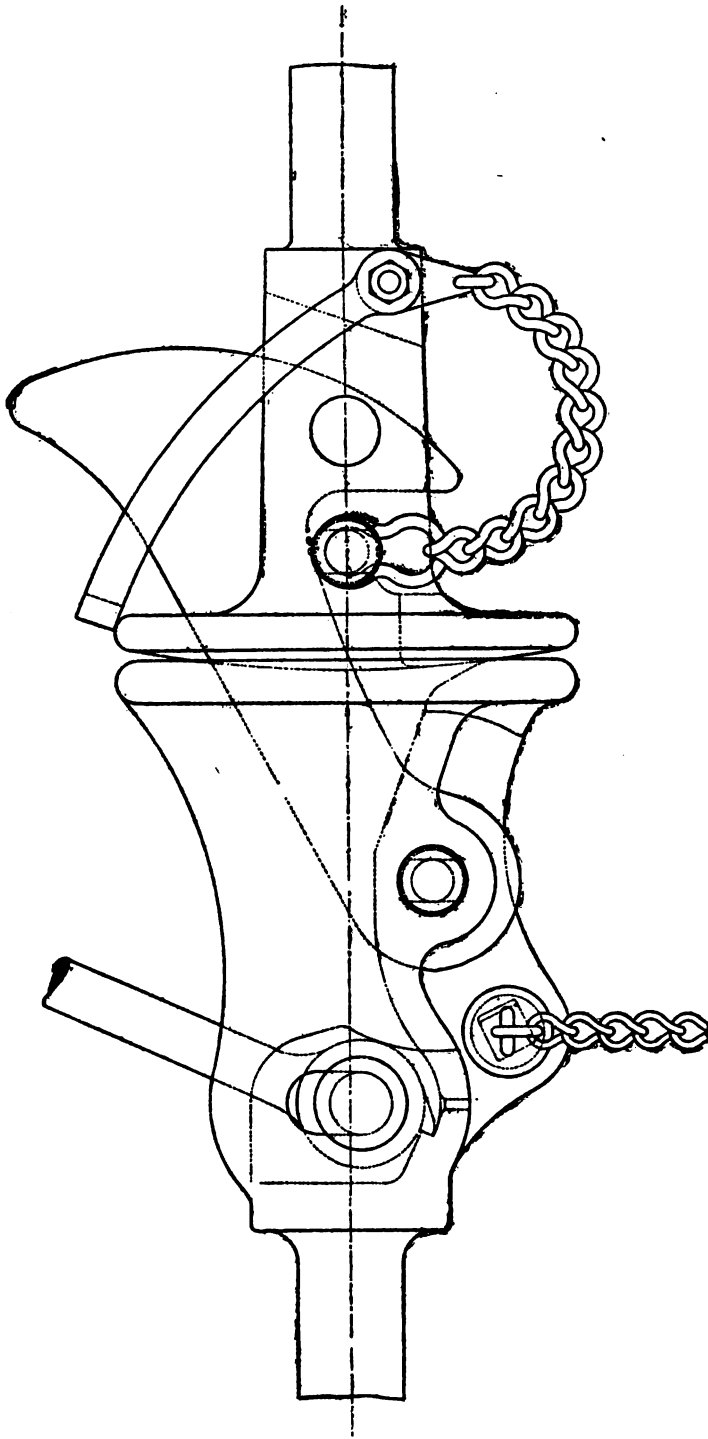


Fig. 19. — The A. B. C. Jepson patent automatic buffer coupler, — The Jepson coupler connected to the standard West Australian Norwegian hook coupler.

faces to come together parallel to each other. The coupler is so designed that in the event of the disc hook pin or the disc hook breaking, the vehicles will not become separated, the hook being retained in position by the surrounding metal of the coupler head.

A further great advantage of this coupler is that it will couple up readily with almost any other form of coupler.

Figure 18 shows the Jepson coupler connected to the standard South African link and pin coupler, the connection being easier to make than the connection between two standard link and pin couplers.

Figure 19 also shows the Jepson coupler connected to the Norwegian hook coupler as used on the West Australian Government Railways. In this case, the disc hook is made easily removable, and is replaced by the standard Norwegian hook, or if the opposing buffer has the hook attached, the pin is replaced and the Norwegian hook engages it. It will thus be seen that it is no more trouble to make this connection than when two hook ends of the standard Norwegian coupler come together.

For connecting to the standard three link chain or the screw coupling as used on British railways, the opening in the Jepson coupler is modified, so that the three link chain when coupled on the hook may hang more vertical; the hook is also increased in height and is given more overhang, and to increase the security of the coupling, the shackle is allowed to rest upon the chain. The three link chain may be coupled and uncoupled from this hook by the shunter's pole in the usual manner, the disc hook remaining in the closed position for this purpose.

The materials from which this coupler is made are as follows :

The buffer head and shank are made from cast steel of special quality, the shank being drawn out under the hammer or forging press to the required form, and afterwards the whole is thoroughly annealed. The disc hook is preferably a steel stamping or it may be cast; the shackle, locking bar and pins are forged steel of suitable quality.

---

[ 628 .216 ]

APPENDIX II.

**Note on the Boirault automatic car coupler.**

Figs. 1 to 9, p. 1319 to 1322.

The automatic coupler devised by Mr. Boirault, engineer on the French State Railways, was designed with a special view to coupling automatically cars of the type most generally used in Europe, without making any alteration in the construction of their underframes or even in the drawbars and buffers now employed.

It consists (fig. 1) of an extensible frame formed of two guides G, bolted together, two slides C, running in these guides and forming an extension to the end of the latter, and a coupling head T, rotating on two bearings supported by the end of the slides. The coupler head, carrying the slides, is held away from the guides by the coiled spring R, resting on the staybolt of the guides. The pins H pass through the guides and the slides without interfering with their relative motion, but limit the extension of the frame under the action of the spring or the strain of traction and transmit the strain to the guides. The device is attached to the car by a lock pin A, which passes through the guides and the slot in the common drawhook. On the other hand, a yoke E, jointed to the guides, serves to suspend the apparatus in a horizontal position when this link engages the drawhook. The coupler head has in its front face (*i. e.*, the face opposite the end sill of the car) two lugs and two rectangular openings (fig. 5), arranged diagonally so that when two cars are coupled the lugs of each of the two heads in contact engage in the openings of the other. The lugs have round holes for receiving locks set in the thick part of the coupler heads. The coupling of the two heads in contact is thus effected by four locks, two locks in each head entering the holes in the lugs of the other.

The two locks in each coupler head are controlled by a lever B (fig. 2), turning on a pivot on the rear face of the head and in the center of the latter.

The coiled spring R (fig. 1) acts on this lever through a ratchet (which also serves to give the spring the proper tension) so that it always tends to make it turn in the direction corresponding to setting the locks, as shown by arrows in figure 2. When the coupling is not made, the lever 3 is locked (fig. 2) in the position corresponding to lifting the locks with a pawl D, pivoted to the lifter arm, and this strikes against a projection F, on the coupler head. It suffices, therefore, to lift the pawl D to set the locks under the action of the spring R.

The pawl D is raised automatically when the lugs in the coupler heads enter the

corresponding openings, thanks to an inclined plane P (fig. 3), provided on the upper lug of each coupler head. The result is that when the lugs have entered entirely into the openings, the pawl D ceases to be supported by the rib F, and consequently the locks set, passing through the corresponding openings in the lugs (fig. 4).

To the ends of the lever B are attached small chains, which are also fastened to the ends of the end sills of the car (fig. 6). By pulling one or the other of these chains by a handle with which they are supplied, the lever B is moved in the opposite direction from the arrows in figure 2, and the pawl D comes back to the position indicated in this same figure. Therefore, to uncouple two cars, it is only necessary to pull simultaneously or successively on the chains of these two cars, and this can be done from either side without getting between the buffers. It is worth noting that the cars are uncoupled without drawing the cars apart, which is not the case with couplers of the American type, which can only be properly uncoupled by separating the cars.

To bring the two coupler heads always exactly facing each other, even on curves and where the two cars have buffer blocks of different heights, the slides C (fig. 1) carry two guiding pieces, one of which, called the socket, is funnel shaped and the other, N, called the "tongue," engages in the socket on the other car. Thanks to the play of the pin A in the slot in the drawhook and the pivoting of the coupler head on its bearings, cars can be coupled in a most satisfactory manner.

The appliance also has at the end of the slides C two lugs (shown in the diagram, fig. 1), which engage the hooks at the ends of the safety chains of the car, if it has them. Thanks to this device, the safety chains are coupled automatically by the action of the coupler heads, and if the drawbar of a car ever breaks, there still remains an elastic coupling between this car and the next, thanks to the drawspring on the second car.

The pin A (fig. 1), which passes through the slot in the drawhook, also acts as a pin for securing the common screw coupler, which must be retained at least provisionally to permit of coupling to cars equipped only with the screw drawgear. For this form of coupling, it is only necessary to unhook the safety chains, lift up the Boirault apparatus releasing the yoke E from the drawhook, and then allow the apparatus to drop down vertically (fig. 7). This can be done in a few seconds by one man (the apparatus weighing about 60 kilograms [132 pounds]), as well as the reverse process of placing the apparatus in a horizontal position.

If it is desired in switching, to run one car against another, without coupling them automatically, it is only necessary to throw one coupler out of service by lifting the pawl and thus setting the locks in advance (fig. 6). To reset the coupler, it is merely necessary to pull one of the chains in order to bring the pawl back to its normal position.

The length of the apparatus is so calculated for freight cars that when the cars are coupled, the buffers are not in contact. On the contrary, for cars running at a

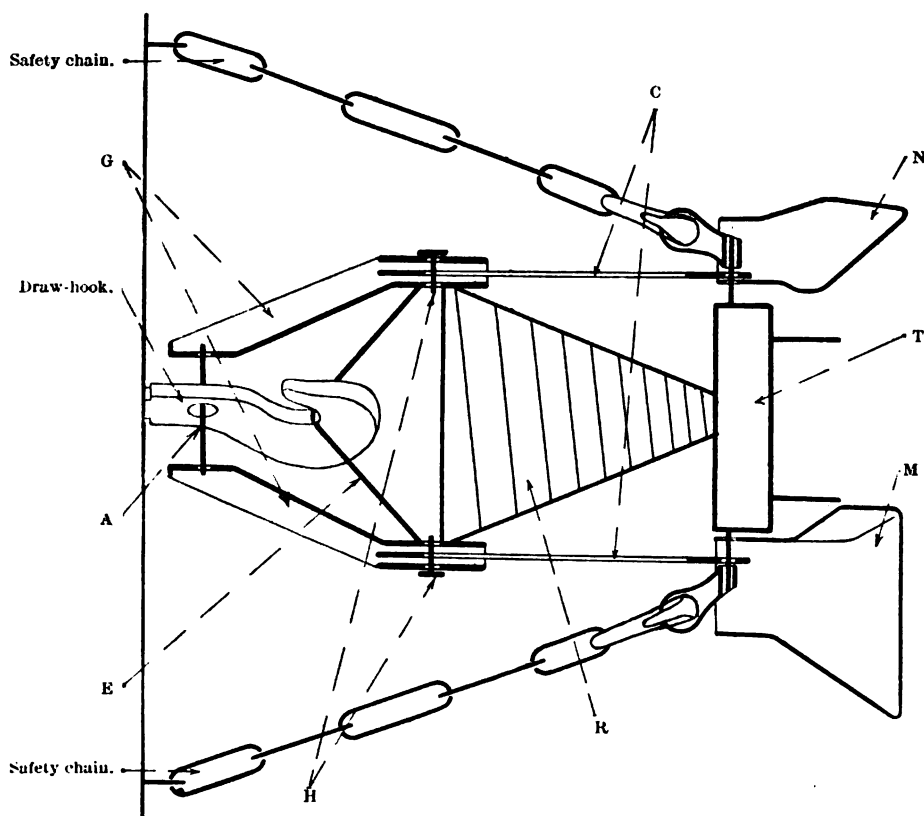


Fig. 1. — Diagrammatic plan.

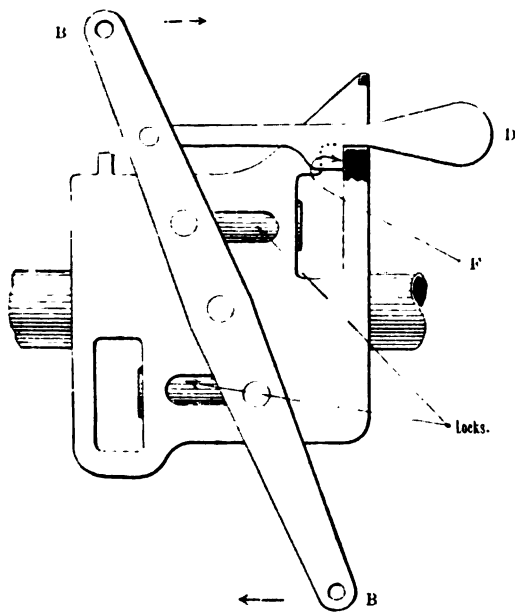


Fig. 2.

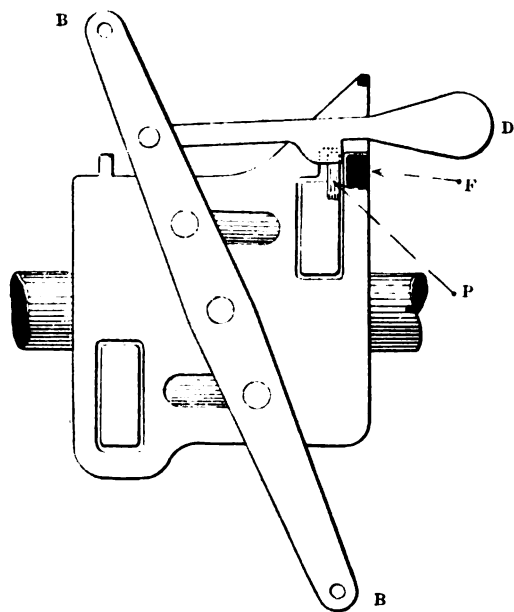


Fig. 3.

*Notes.* — Figures 2, 3 and 4 show the reverse of the coupler head.

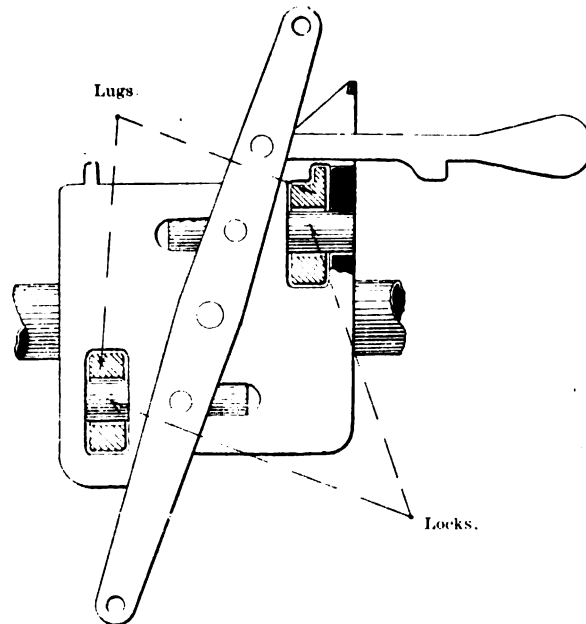


Fig. 4.

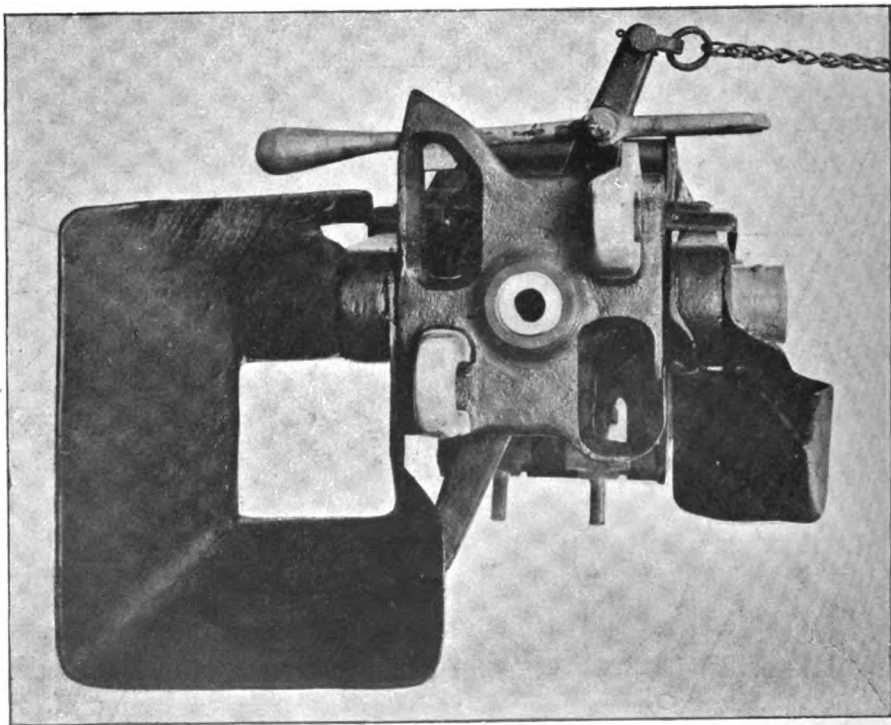


Fig. 5. — Front of the coupler head (locks open).

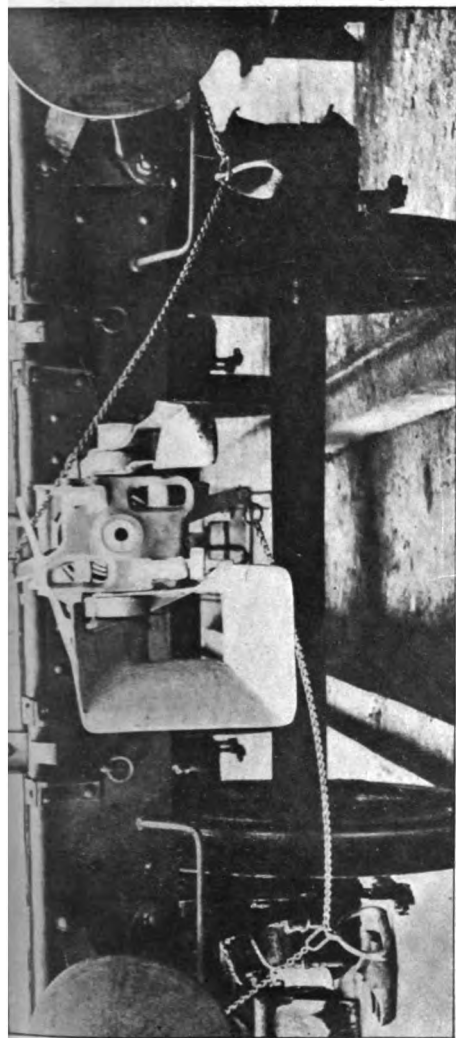


Fig. 6. — Appliance (front view), the locks closed to prevent coupling.

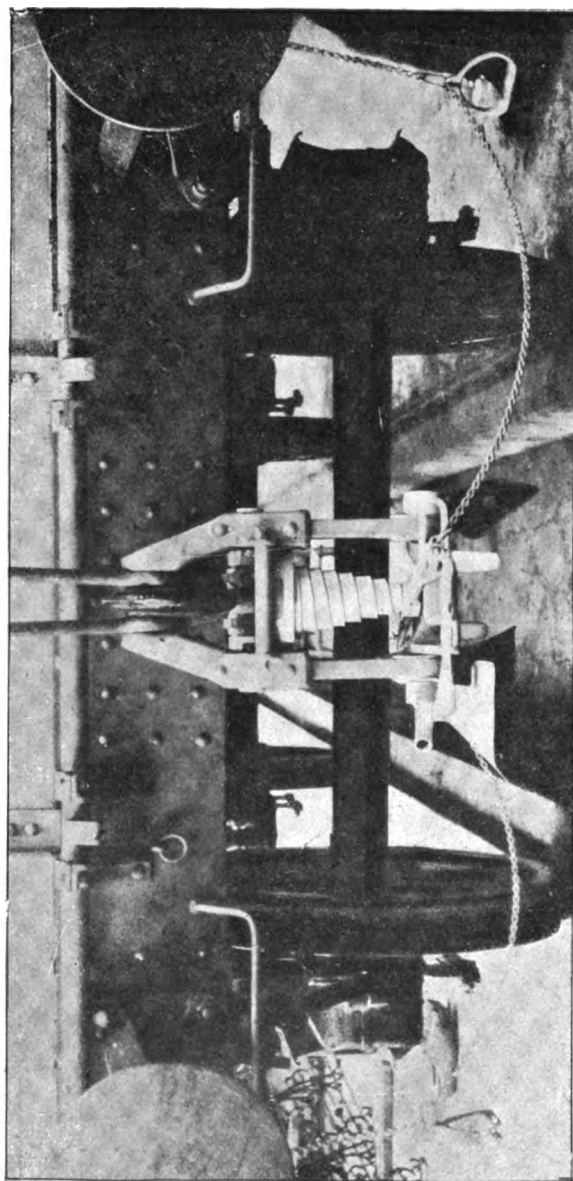


Fig. 7. — Appliance situated vertically for ordinary coupling.

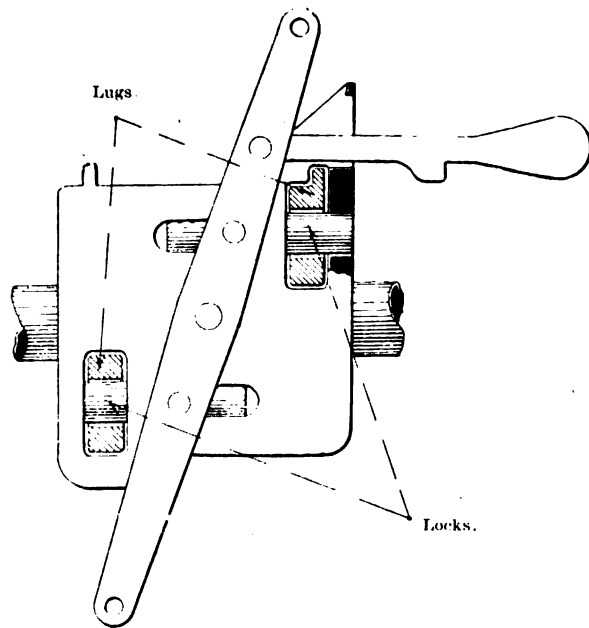


Fig. 4.

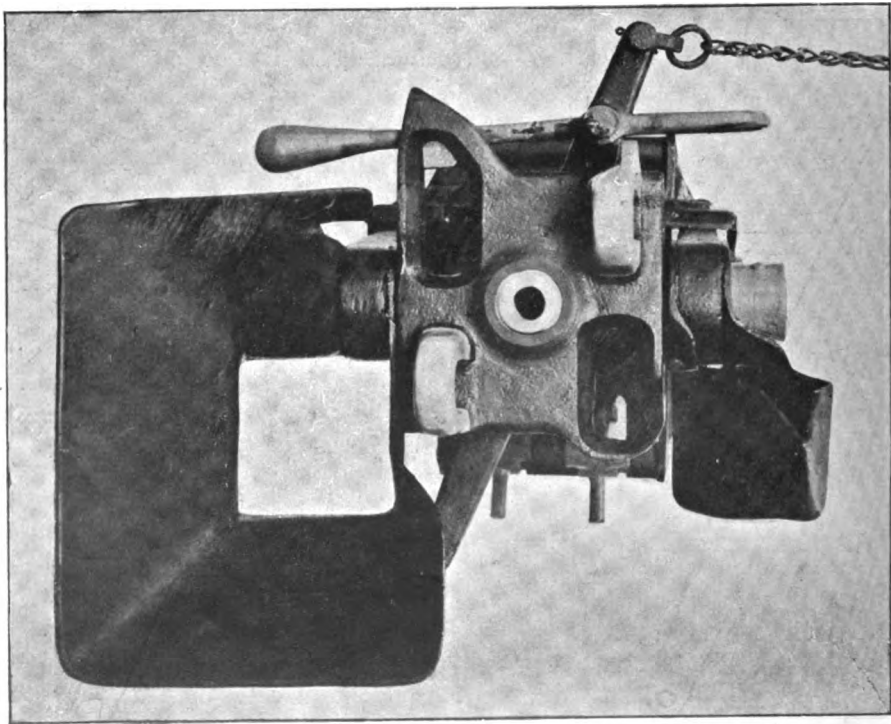


Fig. 5. — Front of the coupler head (locks open).

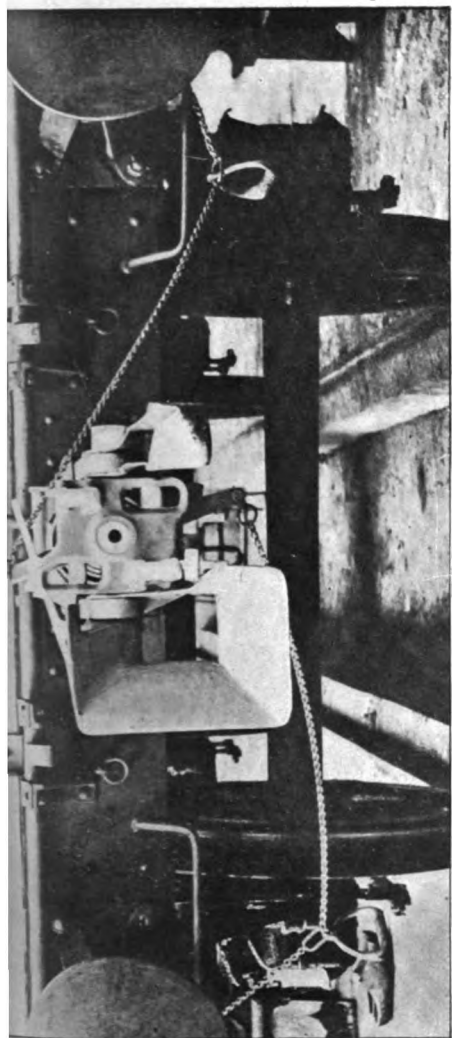


Fig. 6. — Appliance (front view), the locks closed to prevent coupling.

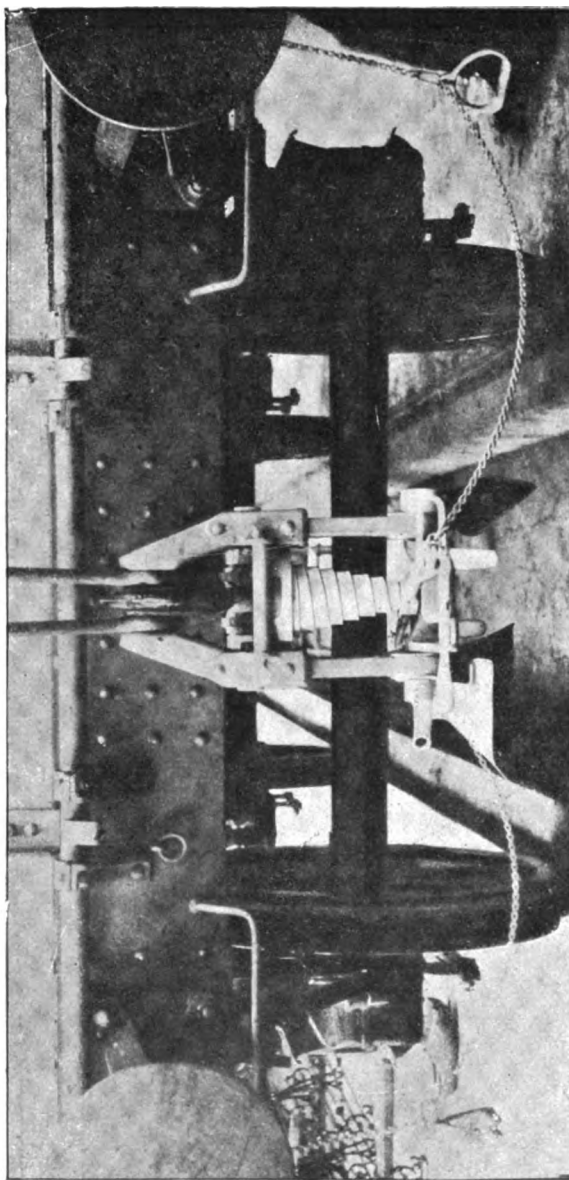


Fig. 7. — Appliance situated vertically for ordinary coupling.

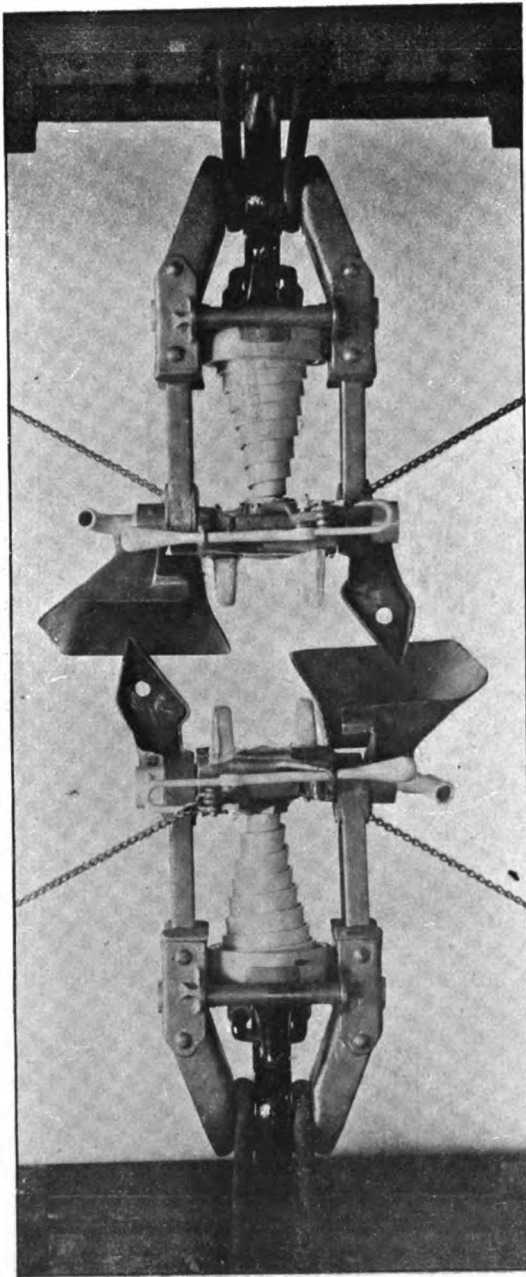


Fig. 8. — Arrangements of appliances before coupling.

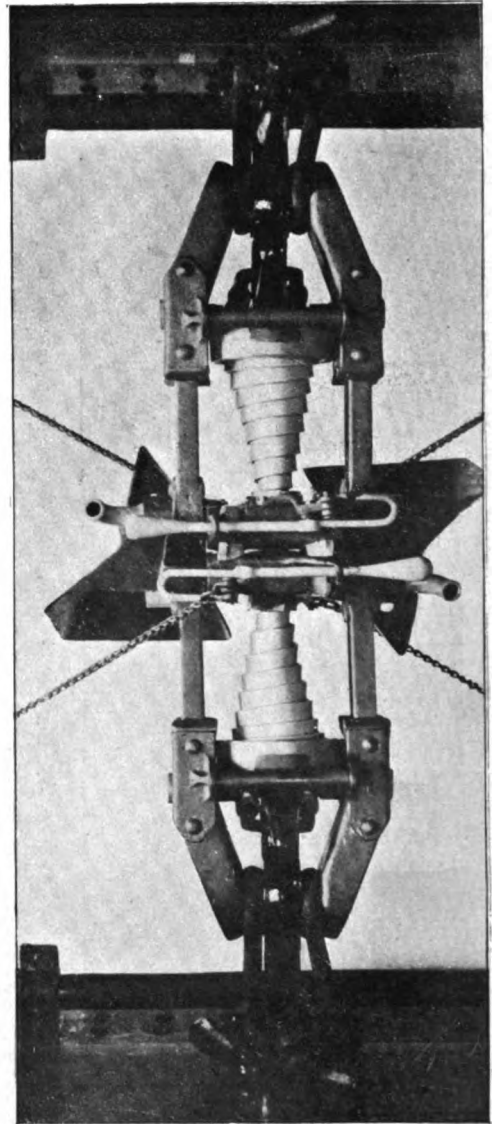


Fig. 9. — Appliances coupled.

high speed, the length is arranged so that the buffers are compressed to the proper extent when the cars are coupled.

The Boirault apparatus also provides for the automatic coupling of the train pipes of the continuous brake. For this purpose the coupler head is made hollow, forming a channel which communicates through one of the bearings with the train pipe of the car by means of a flexible hose connection. Finally, the opening at the end of the channel is fitted with a rubber washer similar to those used on common hose couplings, which prevents leakage (figs. 5 and 6).

This device has undergone many tests and has been tried for two years on a number of freight cars on the French State Railways and has always worked in a perfectly satisfactory manner, without a single breakdown. It has even been found, in very violent collisions in the course of switching and making up trains, that the buffers and end sill of a car have been very badly damaged, while the Boirault apparatus has not suffered in the least. This is due to the fact that the flexibility of the spring in this device is considerably greater than that of the buffer springs of the cars.

## MISCELLANEOUS INFORMATION

---

[ 686 .256.5 ]

### 1. — Automatic signals in Great Britain and on the Continent.

(*Railway Age.*)

Two reports on automatic signalling were presented to the International Railway Congress at Washington. One was by Mr. C. H. Platt, late general superintendent of the New York, New Haven & Hartford Railroad (which was reprinted in a condensed form in *The Railway Age* of October 21, 1904, page 586) <sup>(1)</sup>, and the other, summarized in *The Railway Age* of October 28, 1904, page 614, was by M. Margot of the Paris-Lyons-Mediterranean Railway of France <sup>(2)</sup>. While Mr. Platt's report contained much useful information, M. Margot's was, in the writers's opinion, the better report, as it reviewed the pros and cons of the subject, noted the disadvantages and drawbacks of the system, as well as the advantages and benefits, and, weighing both, pronounced a careful judgment.

It must appear a remarkable fact to American railway officers that so little progress has been made in automatic signalling in other lands. On the continent there are five installations : Auxerre-Laroche, Paris-Lyons-Mediterranean of France; Bordeaux-Langon, Midi of France; two junctions on the Ceinture of Paris; Metropolitan of Paris; one on the Austrian Southern. In England there are six installations : Andover-Grately, London & South Western; Alne-Thirsk, North Eastern; Woking-Basingstoke, London & South Western; Liverpool Overhead Railway; Metropolitan District Railway; Great Northern & City Railway.

Of those on the continent, the first four were carried out by the continental representatives of the Hall Signal Company, and that in Austria was locally designed. The Hall installations are not provided with track circuits. The Metropolitan of Paris is an electrically operated line. Each station is provided with rear and advance and no distant signals, which were originally on the normal clear plan, but were subsequently altered to normal danger. No signal can be cleared unless the preceding train has passed two signals in advance, so that, as in the New York subway, each train is protected by two signals at danger.

In England, the Liverpool Overhead and Metropolitan District are electrically operated lines, the latter having recently been converted from steam worked. The former was the first installation in England and was designed by Timmis, the signals being operated by solenoids. It has

---

<sup>(1)</sup> Vide *Bulletin of the Railway Congress*, No. 9, September, 1904, p. 1003.

<sup>(2)</sup> — — — — — No. 12, December, 1904, p. 1613.

no track circuit. The Metropolitan District was signalled by the Westinghouse Company and has track circuits. The signals are operated on the electro-pneumatic principle; they have an overlap of 300 feet and there are no distant signals. The Andover-Grately and Woking-Basingstoke installations are electro-pneumatic on the low pressure principle. They have no overlap. The Alne-Thirsk has the Hall electro gas signal and has an overlap of 1,200 feet. The Great Northern & City was signalled by Spagnoletti. It is also an electrically operated line without track circuits, and the signals are all electric discs. Except the Alne-Thirsk signals, which are normal danger, all automatic signals in England are normally clear.

These figures do not indicate much demand for automatic signals, and it may be of interest to ascertain the cause for this. Such a method of operation is generally regarded as an American institution, so it may surprise many to hear that it was thought of in England as long ago as it was in America. In Mr. Edward C. Carter's report to the Paris congress of 1900 <sup>(1)</sup>, it was stated that the earliest application of this class of apparatus in America which was in any degree successful was in 1871. It was in 1872 that W. R. Sykes introduced some automatic signals on the Metropolitan District Railway, already referred to. But about 1850, Tyler developed a scheme whereby the passage of a train out of a section, unlocked the signals at the entrance to that section. This was the foundation of "lock and block" or "manual control" — a kindred subject to automatic signalling.

In October, 1860, William Bull filed a British patent by which track circuits and cab signals were anticipated. He proposed to make the rails conductors of the current, so that the train could, at certain points, be communicated with, or the conductor or driver could communicate with another train or station. Portions only of the rails would be insulated, and an indicator on the engine would show when those portions were being traversed and also register the distance traveled.

The system introduced by Sykes consisted of a series of electrical rail contacts which caused a disc signal to be put to danger as a train passed it, and the disc signal immediately in the rear to be put to clear. The signals consisted of a fixed lamp with a movable screen, with red glass, so that a red light was shown when the signal was at danger, and a white light when the signal was cleared. Such an arrangement, by the way, is that adopted on the Metropolitan of Paris already referred to, except that the lights shown there are red and green.

Nothing came of these arrangements, and no automatic signals, except experimental ones subsequently removed, were adopted in Great Britain until 1893, and a few years later on the continent. Various causes contributed to this, so far as Great Britain is concerned, and these apply generally to the continent also. One leading factor in the case was that, wherever a tower was provided, there were generally some switches to be operated. Even at outlying places, where there was neither a station nor a sidetrack, it was customary to provide a crossover between the main lines. Towermen were required to advise the line in advance of the approach of trains, to intimate the class of train (passenger or freight, express or accommodation, special, etc.), to take any action necessary, should a passenger be giving signals of alarm, any doors be open, any vehicle on fire, any journal boxes hot, any load shifted or any train broken loose. They were useful in sending intimation of an accident, and arranging for all traffic being carried on one line. Towermen were also required to advise trainmen how following trains

---

<sup>(1)</sup> Vide *Bulletin of the Railway Congress*, No. 12, December, 1899, p. 1543, and *Proceedings of the sixth session* (Paris, 1900), vol. V, p. XXV-3.

were running, and to give instructions for one train to sidetrack to allow a more important train to pass. In connection with this, it must be remembered that the train dispatcher does not exist in England. The towerman knows how trains are running and takes action on his own initiative.

These points were well brought out by M. Margot, who, in connection with that feature of the service a towerman can render in case he sees anything wrong with a passing train, quotes the following statistics : On the Paris-Lyons-Mediterranean, from Laroche to Dijon, there are 36 signal towers and an average of 80 trains in both directions per diem. During the year 1901, these men stopped 97 trains for the following reasons :

Lights of tail lamps (markers) out . . . . .	4
Defective couplings . . . . .	28
Jammed brakes and hot journal boxes . . . . .	26
Carriage doors open and defective loading . . . . .	20
Miscellaneous . . . . .	19

On a section of the French State Railway 21 miles in length, where the daily average number of trains is 76, there were 70 trains stopped during the year 1901, 60 of them because the lights of the tail markers were out.

On the Orleans Railway, with 14 signal towers and 110 trains per day, there were 70 trains stopped during the same period.

For such contingencies and purposes as those related, the human agency only, and not a machine, is available. Again, there was not the same need as in America. From the beginning of railways, there had been men whose sole duty it was to protect the movements of trains. These were originally called " policemen ", who displayed red or white flags. When semaphore signals were introduced, they operated them, and subsequently they worked the block system, so that the question of providing automatic signals as an alternative to providing towers and towermen never seriously arose, as the men were already there. Labor, too, was, and is, cheaper in England, and cheaper still on the continent, and as stations and sidings are close together (as compared with the vast stretches in America), so there was no difficulty with regard to towermen, repairmen and others having to live miles from any civilization, as would often be the case in America if the railroads were protected by signals operated by towermen.

It was also natural that British railway men, belonging, as they do, to such a conservative nation, should be slow to move and to abandon old, well tried ideas, which have stood the test of time, in favour of those which had not then passed out the experimental stage. The human agent, it was true, was expensive, but it was reliable.

But one of the leading factors that have militated against the use of automatic systems, has undoubtedly been the control exercised by the British Board of Trade. Such oversight is unknown in America, and consequently there is greater freedom to adopt new ideas, besides a natural aptness to secure labor saving devices. But in Great Britain no new system of signalling may be adopted until has been approved by the Board of Trade, and while they are always willing to consider any proposals and will give encouragement to any practical idea — and this is particularly true of the present generation of inspection officers — yet they naturally are cautious, and will not give the mark of approval to any new method of working, until it has stood the severest possible tests under all the various conditions likely to arise.

There is the same difference of opinion in Great Britain as in America as to the merits of

“normal danger” and “normal clear”. The mention of the fact that all the automatic signals placed in England, except those on the Alne-Thirsk section, are normal clear may have given rise to a wrong conclusion. In England, as in America, the normal danger patent is held by one signal company and, therefore, it is natural that the signals placed by other companies should be normally clear. This year, the British patent herein expires and then any company may manufacture them on the normal danger principle. As the question will then be robbed of its prejudices in part, if not wholly, a right decision may possibly then be found. As in America, there are railway officers in Great Britain who advocate “normal danger” for automatic signals, on the ground that that is the question for mechanically operated signals. Also there are others who prefer “normal clear” for the benefits claimed in America by the advocates of that principles (fewer circuits, easier inspection, etc.).

Not so much difference of opinion exists in Great Britain as to the “overlap”. They are provided in all installations, except those on the London & South Western, and are favored by the majority of British officers. Such a margin of safety corresponds with the standard block regulations which do not allow a second train to be accepted from the tower in the rear until the first one has gone forward on its journey.

The Westinghouse signals on the District Railway are not only provided with an overlap of 300 feet, but are fitted with an automatic stop similar to those in the New York subway.

There is one feature in connection with automatic signals about which some officers feel uneasiness and that has relation to the steps to be taken when a driver finds an automatic signal at danger. As a rule he must stop for a short period — from one to four minutes — and then proceed “under caution”. This, they fear, may one day lead to trouble, and especially if the signals are not kept in the highest state of perfection. If not well looked after, they will be frequently out of order, and that will often lead to signals being passed at danger and drivers finding the section clear. This will, in time, lead them to treat signals so shown with less respect and to travel through the section at ordinary speed, and some day it will be found that the signal was “on” for its legitimate purpose, but too late to avert a disaster. These fears are no doubt exaggerated, but they indicate the state of mind of some British officers.

Further, automatic signals are an expensive item, and where mechanically operated signals already exist — and they are in use on every line opened for traffic — their introduction can only be justified when the expense can be recouped by economies effected by signal towers being closed and operators dispensed with. These cases are, however, rarer than is generally imagined. The average cost in England, including fitting the track circuit and running line wires, is about \$500 per arm, or \$1,000 for a 2-arm signal, while the maintenance is high, varying, according to Mr. Platt's report, from \$60.13 to \$103.57 per arm a year. Then each signal has to bear an annual charge of \$10 per arm for lighting, and in England there are also fogging expenses. In the case of new lines as yet unsignalled, it is, no doubt, much cheaper to provide automatic signals, instead of equipping the road with signal towers, operators and mechanical signals. But new lines are most uncommon now in Great Britain, and the question will nearly always have to be considered in relation to existing lines where there are already signal towers and signals. These have been paid for, and naturally there is little switching and where the chief duty of the operator is to work the block instruments and signal trains, these men may, if automatic signals be provided, be taken out of the towers, and need only go in when any switching has to be performed. Such cases will appeal to railway managers, but it takes a good many such economies to pay for automatic signals in Great Britain.

Let it be imagined that they are installed on a British road, on a stretch of double track 20 miles

in length, with signals a mile apart. This would require forty 2-arm signals, or 80 arms in all, which would cost, say, \$40,000. The annual charges would be :

Interest at 4 per cent on \$40,000 . . . . .	\$1,600
Sinking fund for renewal in 20 years ( $\$40,000 \times \$0.033$ ) . . . . .	1,320
Lighting 80 signals at, say, \$10. . . . .	800
Fogging 40 distant signals, at say, \$5 . . . . .	200
Maintenance of 80 signals, at say, \$75. . . . .	6,000
Total. . . . .	\$9,920

The average pay for a British towerman is \$5.50 per week — \$286 per annum — to which may be added \$14 for his uniform, vacation payment, etc., making \$300 in all, so that it would require 66 operators to be dispensed with to justify this expense.

Track circuits are giving better results in Great Britain than was anticipated. Some years ago, leakage was caused through contact with the ballast, and there have been at least three cases where engines have stood upon sand without short circuiting the current. These, however, can be met, the one by better attention by trackmen, and the other, possibly, by instructing enginemen not to stand upon sand or to see that some wheel of the engine is on the bare rail. But some British companies find that their rolling stock, if pushed on to a section of track circuit and not taken by an engine, fails to short circuit, and it was to this that Colonel Yorke referred in the discussion at the Washington congress <sup>(1)</sup>, when he said he had always been a strong advocate of track circuits, but he had observed, at least in English practice, that some cars with two axles do not invariably complete the circuit and, consequently, do not operate the signals. This has greatly shaken his faith in the efficiency of automatic systems depending on a track circuit. This feature is in addition to the deficiency arising from rusty rails and rusty wheels, also from the well known difficulty associated with wheels with wooden discs between the axle and the tire. In England it is considered that it should also be a certainty that, when the sectionmen put their trolley on the rails, the signals protecting the section are at danger, so as to render flagmen unnecessary. In America a different opinion exists, but in England protection is called for by rule: yet it has been found that automatic signals do not respond, and if absolute confidence cannot be obtained, then flagmen must be sent out to protect the trolley in the rear, a service that ought not to be demanded where there are automatic signals.

[ 621 .135.5 (.04) ]

## 2. — Comparative test of large locomotive air pumps.

Figs. 1 to 7, pp. 1332 and 1333.

(*The Railway Age.*)

When the locomotive air pump was first invented, the degree of prominence that apparatus was destined to attain in the conduct of railway transportation was not foreseen. Since the advent of air brakes numerous designs of air pumps have been brought out, each answering its intended

<sup>(1)</sup> Vide *Bulletin of the Railway Congress*, No. 7, September, 1905, p. 1959.

purpose, but during these years of pump development, the chief efforts have been centered in designing apparatus occupying little space, light in weight and of sufficient air producing capacity to supply the needs, these desiderata being looked upon as of greater importance than designs contributing to steam economy.

With the advent, however, of high speed brakes, long trains of air braked cars and numerous "parasites," such as bell ringers, track sanders, water scoops, air pressure for Pullman cars, and other accessories on engines and cars, all contributing through operation and leakage to exactions on the air pump, there has been created a demand for pumps of great air producing capacity until a stage of steam consumption has been reached the result of which is a serious drain upon the coal pile.

TABLE 1.

*Comparative test of locomotive air pumps.  
Working against constant pressure.*

Serial number of test . . . . .	6-9	6-10	Per cent in favour of W. C. C.	6-11	6-12	Per cent in favour of W. C. C.	6-13	6-14	Per cent in favour of W. C. C.
Style of pump . . . . .	W. C. C.	N. Y. 5 D. P.		W. C. C.	N. Y. 5 D. P.		W. C. C.	N. Y. 5 D. P.	
Steam pressure. . . . .	175	175	..	175	175	..	175	175	..
Constant air pressure pumped against. .	130	130	..	100	100	..	70	70	..
Cubic feet free air pumped . . . . .	616.8	616.8	..	625.4	625.4	..	534.8	534.8	..
Duration of test, minutes and seconds. .	5-43.2	8-32	49.2	4-43.4	6-14.2	32.1	3-31.6	4-22.2	23.9
Cubic feet free air pumped per minute . .	107.9	72.3	49.2	132.4	100.3	32.1	151.6	122.4	23.9
Cycles per minute. . . . .	55.1	47.1	..	64.8	50.2	..	73.4	65.9	..
Weight of steam used, pounds . . . . .	124.5	251.0	101.6	110.8	206.3	86.2	85.8	155.5	81.4
Steam per 100 cubic feet free air, pounds .	20.2	40.7	101.6	17.7	33.0	86.2	16.0	29.1	81.4
Cubic feet free air per pound steam . . .	4.96	2.46	101.6	5.65	3.03	86.2	6.24	3.44	81.4
Volumetric efficiency, per cent . . . . .	86.0	68.4	25.8	89.6	75.5	18.7	90.7	82.8	9.6
Temperature, degrees Fahrenheit :									
At pump discharge :									
Initial . . . . .	320	320	..	298	370	..	310	360	..
Final. . . . .	400	470	..	384	470	..	368	440	..
In first of three connected reservoirs :									
Initial . . . . .	140	168	..	172	185	..	196	194	..
Final. . . . .	169	190	..	194	205	..	206	206	..
Atmosphere . . . . .	75	76	..	74	78	..	78	79	..

It is a generally accepted belief that the Westinghouse 11-inch pump was of ample capacity to supply air for all conditions of train service, but when, a year or more ago, the New York Air Brake Company placed upon the market a duplex pump of considerably greater capacity than

the 11-inch pump, it was received by many railroad men with much favour, being looked upon as an apparatus more capable of meeting modern requirements than any of its predecessors

It is evident that the sentiment of those using air pumps is in the direction of abnormal air capacity, as compared to former practice, and, to those skilled in the art, that the combination of such capacity and steam economy cannot be obtained with simple pumps. The Westinghouse Air Brake Company, therefore, has produced a pump of superior capacity as compared to any heretofore used on locomotives, and with a factor of steam economy far in excess of anything previously attempted.

TABLE 2.

*Comparative test of locomotive air pumps.  
Working against increasing pressure as in charging reservoirs.*

Serial number of test . . . . .	7-15	7-18	Per cent in favour of W. C. C.	7-16	7-19	Per cent in favour of W. C. C.	7-17	7-20	Per cent in favour of W. C. C.
Style of pump . . . . .	W. C. C.	N. Y. 5 D. P.		W. C. C.	N. Y. 5 D. P.		W. C. C.	N. Y. 5 D. P.	
Steam pressure. . . . .	150	150	...	150	150	...	150	150	...
Initial air pressure . . . . .	30	30	...	30	30	...	30	30	...
Final air pressure. . . . .	70	70	...	100	100	...	130	130	...
Cubic feet free air pumped . . . . .	98.9	98.8	...	173.1	173.0	...	247.3	247.1	...
Duration of test, minutes and seconds. . . . .	0-46	0-55	...	1-26.4	1-47	...	2-21	3-08	...
Total cycles. . . . .	52	57	...	95	98	...	137	154	...
Weight of steam used, pounds . . . . .	15	19	...	29.5	52.8	...	44	85.3	...
Required to compress 100 cubic feet free air from initial to final pressure :									
Time, seconds. . . . .	46.5	55.6	19.7	49.9	61.9	24.0	57.0	76.1	33.4
Steam, pounds. . . . .	15.2	29.3	93.5	17.0	30.5	79.0	17.8	34.5	93.9
Temperature, degrees Fahrenheit :									
At pump discharge :									
Initial . . . . .	240	240	...	255	275	...	302	350	...
Final. . . . .	264	280	...	293	330	...	344	400	...
In first of three connected reservoirs :									
Initial . . . . .	165	162	...	160	162	...	159	174	...
Final. . . . .	170	168	...	172	170	...	175	190	...
Atmosphere . . . . .	76	78	...	75	78	...	77	78	...

The advent of this pump has created no little interest and favourable comment on the part of railway officers who, upon investigation, recognized its simplicity, capacity and economical qualities. With a view of determining in a practical way the capabilities of this type of air compressor, a comparative test of the Westinghouse compound and the New York No 5 duplex pumps was somewhat recently made by the Lake Shore & Michigan Southern Railway. The

schedule of tests was prepared and conducted by the engineering department of the road under the direction of the chief mechanical officers, there being present during the demonstration several prominent air brake experts of the road, as well as representatives of the two air brake companies.

TABLE 3

*Comparative test of locomotive air pumps.  
Orifice tests.*

Serial number of test . . . . .	7-21	7-22	7-20	7-23	7-24	7-25	7-26
Style of pump . . . . .	W. C. C.	N. Y. 5 D. P.	W. C. C.	W. C. C.	N. Y. 5 D. P.	W. C. C.	N. Y. 5 D. P.
Orifice in diaphragm :							
Diameter, inches . . . . .	17/64	17/64	17/64	19/64	19/64	23/64	23/64
Area, square inches . . . . .	·055420	·055420	·055420	·069227	·069227	·101434	·101434
Steam pressure . . . . .	200	200	156	200	200	200	200
Initial air pressure . . . . .	118	100	100	100	88	70	63
Final air pressure . . . . .	120	102	100	104	88	73	63
Duration of test, minutes . . . . .	2	2	2	2	2	2	2
Cycles per minute . . . . .	67	65·5	57·5	73·5	69·5	81·5	75·0
Steam used per minute, lb. . . . .	25·6	40·6	19·3	27·9	43·8	29·4	40·5
Temperature, degrees Fahrenheit :							
At pump discharge :							
Initial . . . . .	242	310	400	300	360	301	410
Final . . . . .	296	360	417	340	420	346	430
In reservoir :							
Initial . . . . .	111	126	234	140	163	170	180
Final . . . . .	122	137	236	153	172	179	190
Atmosphere . . . . .	69	72	69	73	70	72	72

To what extent the efforts of the Westinghouse Air Brake Company have proved successful, is presented in the performance of their 8 1/2-inch cross compound pump, a partial record of which is presented herewith in a series of tables and a number of diagrams plotted from the data found therein. The tables and diagrams are self explanatory and clearly show the superiority of the Westinghouse pump, both in economy and capacity.

A very complete apparatus was employed for the tests, making entirely practical a comparison of air delivered, steam consumed, temperature of both free and compressed air, as well as the general working of the pumps during the experiments, the apparatus used being arranged as shown in the accompanying sketch.

A locomotive boiler furnished the steam. The steam passed through a covered receiver, which furnished a means for controlling the pressure and also served as a separator. The exhaust steam from the pumps was condensed in a surface condenser and weighed in the barrel

arranged as shown. The delivery pipes of the pumps were connected to the constant pressure reservoir No. 3, the overflow from it being alternately measured in the measuring reservoirs Nos. 1 and 2. In arranging the pumps and reservoirs, an effort was made to have the pipe volume of each pump the same. The difference was slight, the Westinghouse pump having the larger volume. Thermometers were inserted in the delivery pipes near the discharge valves of the two pumps and in reservoir No. 3. Pressure gauges were attached to reservoirs Nos. 1, 2 and 3 and to the steam receiver. The strokes of the pumps were taken with an ordinary reciprocating counter. The whole apparatus was arranged so that the conditions were almost identical for both pumps, thus avoiding the necessity of making corrections for observations.

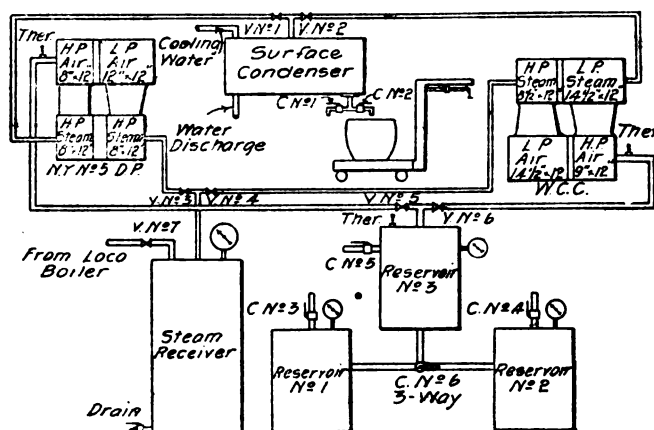


Fig. 1. — Comparative test of air pumps.

The New York No. 5 duplex pump has two  $8 \times 12$ -inch steam cylinders and 8 and  $12 \times 12$ -inch air cylinders; the Westinghouse compound has  $8 \frac{1}{2}$  and  $14 \frac{1}{2} \times 12$ -inch steam cylinders and 9 and  $14 \frac{1}{2} \times 12$ -inch air cylinders. The New York duplex pump takes in free air at both air cylinders, one piston resting while the other is in motion; the Westinghouse compound takes free air at the low pressure air cylinder only, both pistons being in motion at the same time but moving in opposite directions.

The piston displacement of the compound for one cycle or revolution is 1.43 per cent greater than that of the duplex.

The order in which the tests were made is given in the tables. The figure preceding the decimal point is the day of the month, and the number after the decimal point is the order of the test on that day. The tests have been divided into three classes as follows :

1° Efficiency and capacity tests with pumps working against constant pressure; the results of some of these are shown on table 1;

2° Efficiency and capacity tests with the pumps working against increasing pressure, as in charging reservoirs. See table 2;

3° Efficiency and capacity tests with the pumps working against an approximately constant pressure, an orifice in a diaphragm being used to approximate the amount of air delivered; some of these are shown on table 3.

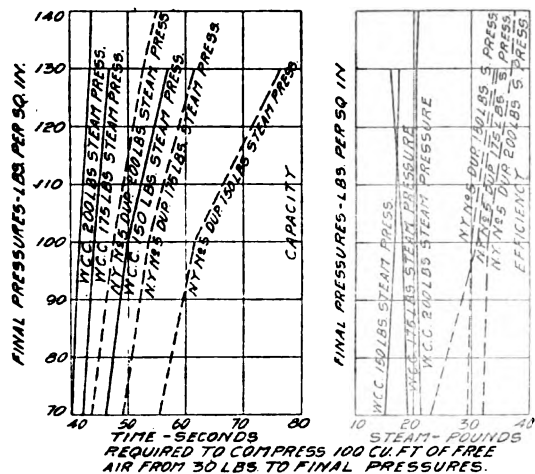


Fig. 2.

Comparative test of air pumps.  
Time and steam required.

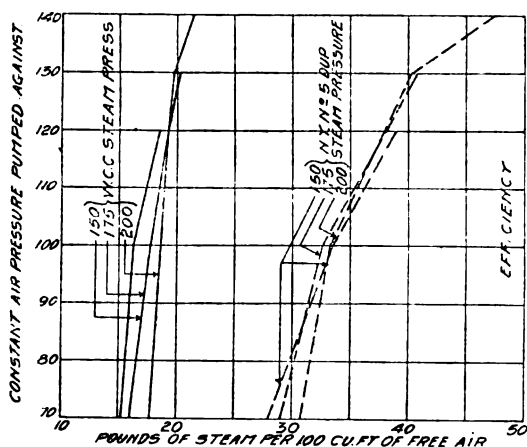


Fig. 3.

Comparative test of air pumps.  
Steam used at various pressures.

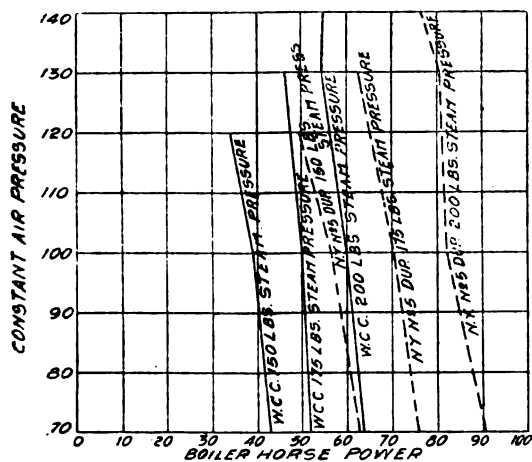


Fig. 4.

Comparative test of air pumps.  
Power required.

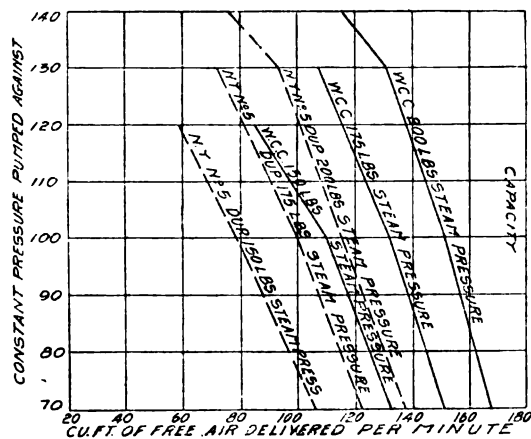


Fig. 5.

Comparative test of air pumps.  
Capacity.

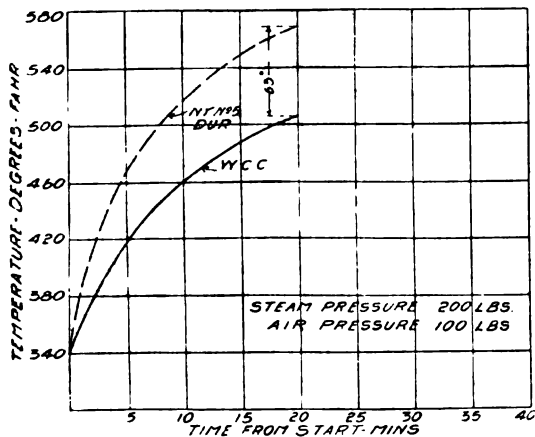


Fig. 6.

Comparative test of air pumps.  
Rise in temperature.

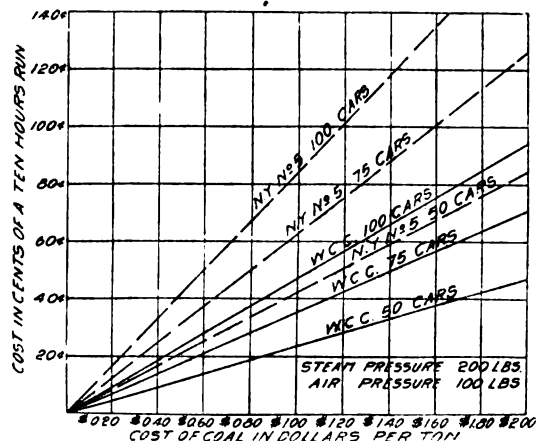


Fig. 7.

Comparative test of air pumps.  
Cost of coal.

In all these tests, the pumps were working at full capacity, except in one instance (*see* table 3, serial number of test 7-29, in which the Westinghouse cross compound was made to deliver the same quantity of air as the New York No. 5 by throttling the steam; while this test was being made the steam pressure in the receiver dropped to 156 pounds. In the increasing pressure or charging reservoir tests, a partial log of which is shown in table 3, the reservoirs were of slightly different capacities, due to the difference in piping, *viz.* : 36-3523 cubic feet for the Westinghouse 8  $\frac{1}{2}$ -inch cross compound and 36-3211 cubic feet for the New York No. 5 duplex pump. In calculating the units of comparison, time and steam per 100 cubic feet of free air, this reservoir difference was considered but was too small to be noticed. The initial pressure in these tests was 30 pounds in each case, increasing to 70, 100, 130 and 140 pounds, this minimum pressure being selected owing to the excessive pounding of the heads of the New York duplex, a condition which largely prevailed when the pump was working against low air pressures.

In this connection, it may be said that the Westinghouse compound worked very quietly, regardless of either high or low air or steam pressures, the tendency to pound being absent even when the throttle was thrown wide open with a high boiler pressure and with little or no air pressure in the charging reservoirs. This is of special importance owing to the "racing" of pumps against low pressure being responsible for a large portion of the failures of pumps of the simple and duplex types.

The comparative diaphragm tests, shown in table 3, were made to illustrate the same points brought out in the comparative efficiency and capacity tests, many railroad men being more familiar with this method of comparing air pumps. These tests also serve as a check on the other results when the pumps were working under similar conditions.

As no accurate formula is known for the flow of air through an orifice, the results of this group can hardly be considered comparative. In all of these tests, except 7-29, the pumps were working to their maximum capacity, and although it is true that both were discharging through the same size of orifice, the higher pressure maintained by the Westinghouse pump throws additional work on it, and this is not fully shown by the amount of air discharged. Test 7-29, table 3, was made, however, in an effort to make the work of the Westinghouse equal to that of the New York pump in test 7-22 and to compare the steam consumption. The Westinghouse pump was therefore throttled, so that both pumps maintained approximately the same air pressure while discharging through the same orifice, with the result that the New York pump used 110 per cent more steam than the Westinghouse. This test also brings out the fact that to do the same work the Westinghouse pump required 156 pounds boiler pressure, whereas the New York required 200 pounds.

In the temperature tests both pumps were run to their maximum capacity, the compound pumping against a  $\frac{19}{64}$ -inch orifice, the duplex supplying a  $\frac{17}{64}$ -inch orifice, resulting in a decidedly higher temperature for the former than would have been the case had each pump supplied the same volume of air. The results of the tests have been plotted in the form of curves and are shown on one of the diagrams.

The temperature of the Westinghouse compound pump was much lower than that of the New York duplex pump for an equal interval between tests; this and the tendency of the New York pump to heat rapidly made it difficult to start it at a low temperature, which could only have been done by long delays between tests. To compensate for this, the compound was run a considerable time before starting the temperature tests, in order to get its temperature equal to that of the New York pump.

The efficiency and capacity features of the first and second class of tests have been plotted,

forming curves which show these results in condensed form and convenient for reference. In addition, several curves have been derived from the results of these tests in connection with tests of another character; thus the curves showing the cost of fuel for a ten hour run with various lengths of train are based on 5505 cubic foot of free air per minute per car and 6  $\frac{1}{2}$  pounds of steam per pound of coal, investigation having shown these figures to be very nearly correct.

It is worthy of notice that the New York duplex piston speed is twice that of the Westinghouse compound for the same number of strokes per minute, due to the fact of one piston resting while the other is in motion.

The simplicity of the compound pump will be appreciated when it is stated that the valve gear is practically the same as that of the 9  $\frac{1}{2}$ -inch and 11-inch Westinghouse pumps. The high pressure steam piston with its hollow rod contains the reversing rod, which operates the reversing valve, and it, in turn, the main valve, which controls steam admission to and exhaust from both the steam cylinders.

The low pressure steam and high pressure air pistons are connected with a solid piston rod, having no connection with the valve gear, being simply floating pistons.

The results of these comparative tests were of a character to prove the superiority of the compound over its competitor in every respect, and such was the consensus of opinion of those witnessing the demonstrations.

It was also made evident that when Mr. Westinghouse designed and patented a compound air pump in 1873 he foresaw, even while the air brake was yet in its infancy, that at some remote period steam economy must become a ruling consideration in locomotive air pump operation, and to judge from the strenuous efforts of railways in the direction of such economy, it would seem that the time has now arrived.

---

[ 636.212.8 ]

### 3. — Weighbridge for determining the loads on the different wheels of locomotives and other rolling stock, with common raising mechanism, on the Zeidler system.

Figs. 8 to 12, pp. 1335 to 1338.

(*Organ für die Fortschritte des Eisenbahnwesens.*)

#### I. — DESCRIPTION.

The weighbridge includes (fig. 8) :

1° The platform M with the column S; it is supported at one side on the knife-edge *n*, at the other on the rollers R; then it has two bearings, the height of which can be adjusted by means of wedges and screws, for

2° The one-armed lever or scale-arm W, taking the load; and

3° The two-armed lever V, which forms the steel-yard and rests on the top of the column S.

The two levers are kept in place by their own weight; they resume the position of equilibrium even when not loaded. They must consequently be adjusted each time.

The raising mechanism consists of :

1° The cam-shafts L, which form one connected whole, and are supported in bearings close to

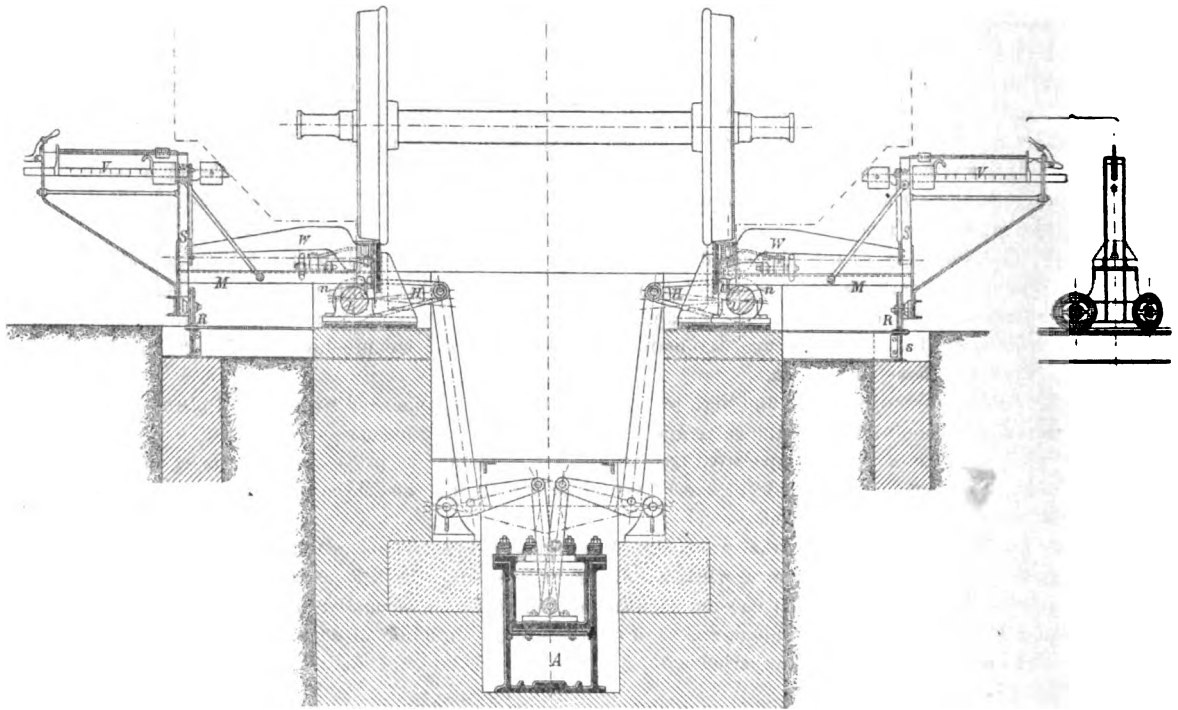


Fig. 8. — Operated by compressed air.

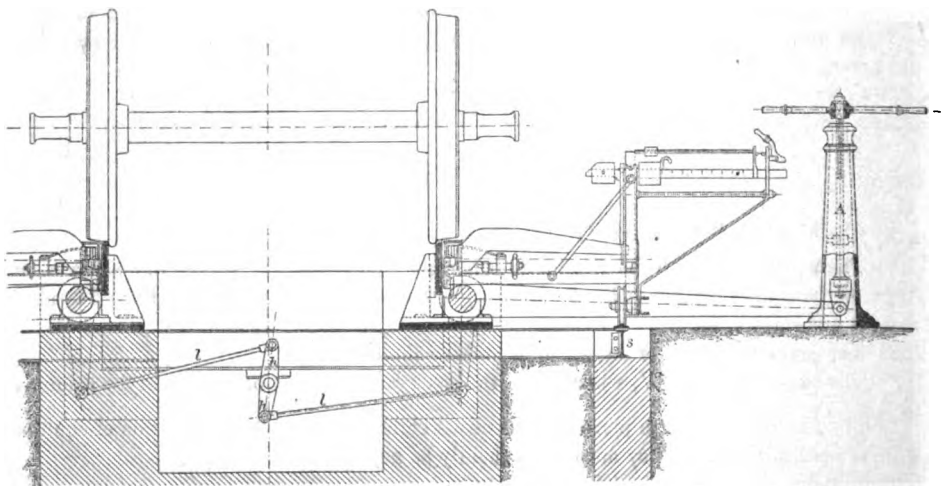


Fig. 9. — Operated by hand, by means of a handwheel and screw.

Fig. 10.

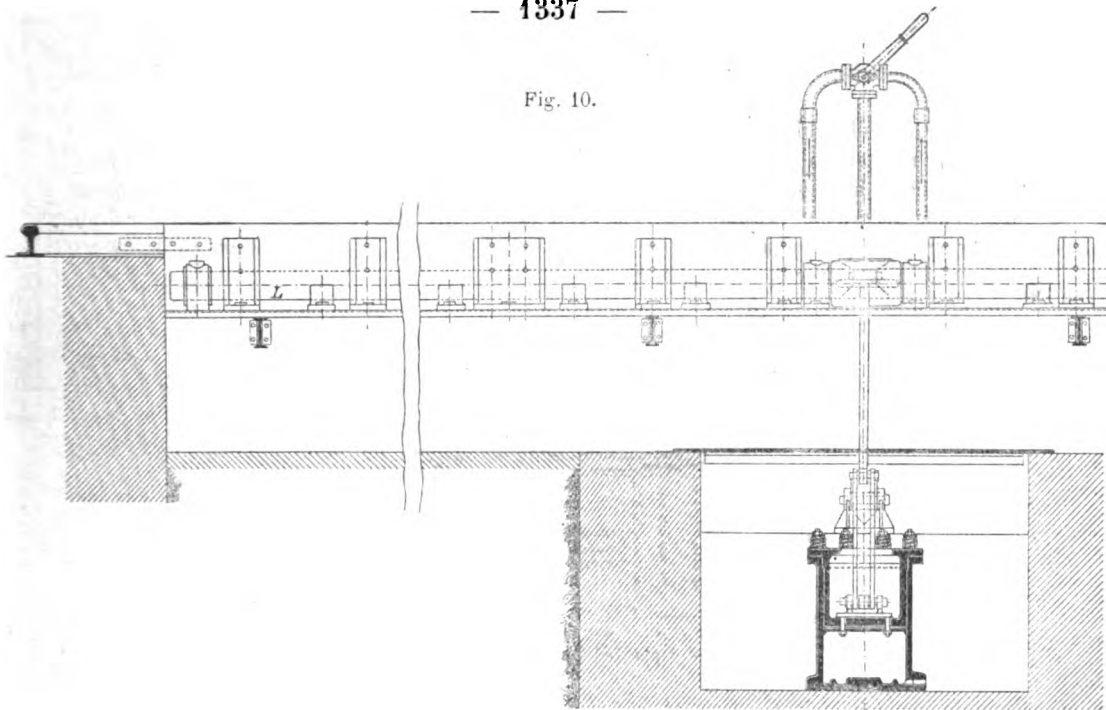
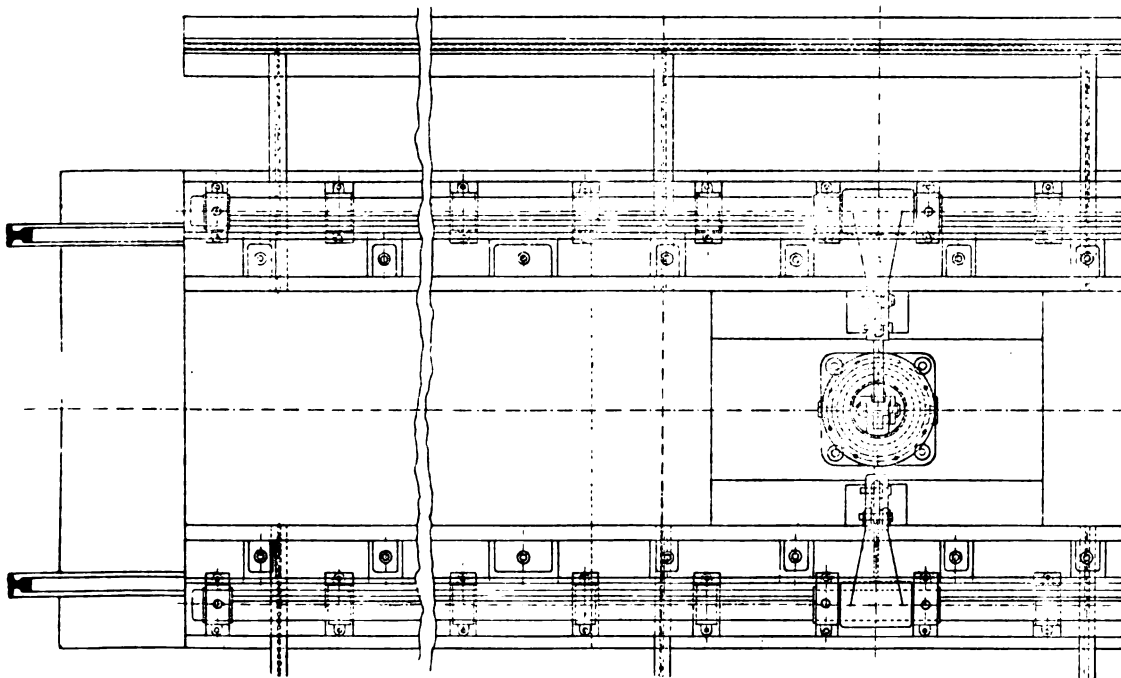


Fig. 11.



and along the rails. The cams are formed by longitudinal grooves cut into the circumference of the shaft;

2° The levers *H* which are keyed on to the cam-shafts;

3° The mechanism *A* which operates these levers. They may be worked by hand, by compressed air, by hydraulic power, by steam or by electricity, as local conditions and requirements may render advisable. Examples are shown in figures 8, 9 and 12; 8 is worked either hydraulically or by compressed air, by means of a piston and cylinder; in 9 a handwheel and screw are used; and in 12 a lever is operated by hand.

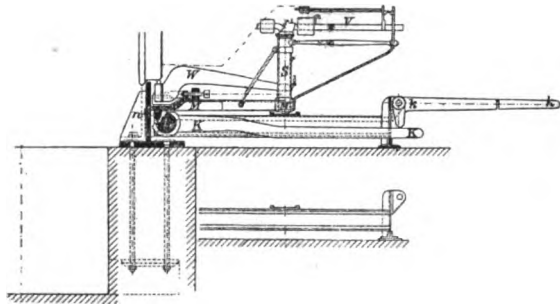


Fig. 12. — Operated by hand, by means of lever.

Each scale is operated on one side, by the rollers, on a longitudinal rail *s*, and on the other, by its knife-edge, on the cams of shaft *L*; so that when this is turned, it is raised or lowered on this side.

The beams *h* and the rods *l* (fig. 9) connect the two cam-shafts *L*; these are close against the sides of the pit so as to leave its cross-section clear over its whole length.

If it is intended to determine the loads on the wheels with the coupling rods and connecting rods in different positions, it is necessary to be able to turn the wheels. In this case, the frame of each scale is fitted on the right and left sides, close to the track rail, with a support which rests on the cam-shaft; this can move with the scale, and on it is a jack, operated by means of a handwheel and an endless screw, which can be turned down outside the track when the locomotive runs on to or off the weighbridge.

These jacks can also be supplied separately and then fitted to the scales.

## II. — OPERATION.

As soon as the locomotive is in place, a scale is placed under each wheel and the clearance between the lower edge of the wheels and the scale-arm is taken up by means of the wedges and screws mentioned above. Then by means of the mechanism described under 3°, the cam-shafts *L* are turned a little, and this raises all the wheels from the track, equally and simultaneously; it is now possible to take the weighings. Finally, the wheels are lowered again on to the rail by the opposite movement, and the wedges are drawn back by means of the screws, so that the wheels are again clear of the scale-arms. The locomotive can then be removed without difficulty.

III. — USE OF LEVER OPERATED BY HAND.

In the case of the weighbridge described above, one common raising mechanism raises and lowers all the wheels simultaneously (figs. 8 and 9). Instead of this, each separate scale may be fitted with a lever K and a handle *k* (fig. 12), the camshaft and its bearings being absent. If the handles *k* are pressed down, the levers K are also pressed down. The raising and lowering of all the wheels is then effected by the simultaneous operation, on a word of command, of all the handles; that is, in the same way as in the case of the well-known Ehrhardt weighbridges. In this simple form, the system described is a good substitute for the Ehrhardt system exclusively used up to the present. The weighbridge for separate wheels has the arrangement described above and also its advantages: the two levers are well supported, there is proper equilibrium, even when no load is on. Such a weighbridge is not heavy and is as portable as the Ehrhardt type; it is operated in the same way. In this case also, the jacks mentioned at the end of part I can be used if the wheels are to be turned; they can form an integral part of the machine or else be supplied separately and fitted to the scales.

[ 628 .245 ]

4. — Whitewashing car used on the Central London Railway.

Fig. 13, p. 1339.

(*The Railway Gazette.*)

The car shown in the accompanying photograph (fig. 13) is used for the whitewashing the tunnels of the Central London Railway. It is a motor car which has been converted for the

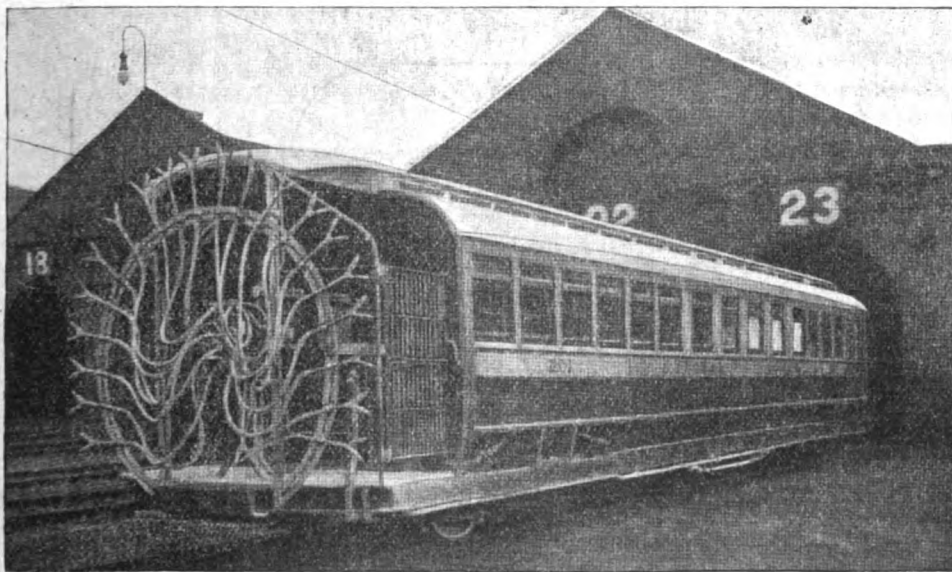


Fig. 13. — Whitewashing car—Central London Railway.

purpose. At one end is the motor for driving the car, while, at the other end, on a circular frame, are arranged a large number of pipes, each terminating in a double branch. The nozzles of these branches are so placed as to distribute the liquid ejected from them. The seats inside the body of the car have been removed and their place taken by a tank for the whitewash liquid of about 800 gallons capacity. From this tank a pipe connects with an electric driving pump, and this pump again, by a main pipe, connects with all the branches fixed on the rear end of the car. The whitewashing process is extremely simple. The car travels along the tunnels at the rate of about 4 miles an hour and the electric pump forces the liquid out of the pipes and sprays it on the roof and sides of the tunnel. About three applications of whitewash are sufficient to properly coat the walls. Thus the work is both quickly and economically performed.

[ 62. (01 & 628 .1 (01 ]

### 5. — Experimental track for trials of superstructures and ballast.

Fig. 14, p. 1340.

(Zeitung des Vereins.)

A track of this kind will shortly be constructed by the Berlin Royal Railway Directorate, in the royal forest near Oranienburg. It will be connected with Oranienburg railway station by a line 2.5 kilometres (1.6 mile) long and will have the shape shown in figure 14. Its total length will be 1,756 metres (1 mile 160 yards); the two straight sections will have a length of 250 metres

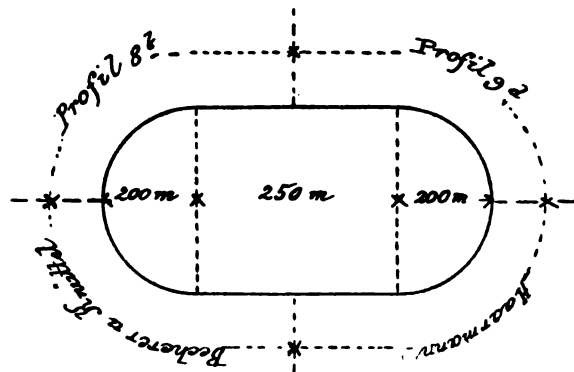


Fig. 14.

(273 yards) each, and the length of each of the two curves, of 200 metre (10 chain) radius, will be 628 metres (687 yards). It is proposed to begin by testing four different types of track : 1° rails 8b with ordinary suspended joints; 2° rails 9d with suspended lapped joints; 3° track with Haarmann strengthened joints; 4° rails 8c with Becherer and Knüttel joints. These four types of track will be arranged so that each of them has the same amount of straight and of curve ; moreover each type will be laid on oak, on beech, and on iron sleepers, and also on pine sleepers with hard wood treenails. Each of these four kinds of sleepers will be supported on gravel and on broken stone ballast from different places. Two electrically driven motor cars, twelve-

wheeled, are to be used in the trials. The energy is supplied as monophasic alternating current, at 6,000 volts and a frequency of 25, by the *Electrizitäts- und Wasserwerk Oranienburg*. The whole installation will probably be ready for use by July 1, 1906.

[ 686 .281 ]

## 6. — The accident at Salisbury.

(*The Railway Times*.)

The deplorable accident to the American boat express which occurred in the small hours of last Sunday morning on the London and South Western Railway at Salisbury is one of the gravest events which we have had to chronicle since the collapse of the Tay Bridge on December 28, 1879. It is gratifying to record that the newspaper press generally has expressed much sympathy with the South Western Company, whose line has hitherto been remarkably immune from serious accidents.

The special train which conveys the passengers of the American line from Plymouth to Waterloo is one of the fastest on the South Western system, and is, we believe, the only train running on this route which does not stop at Salisbury Station. Last Saturday the boat express left Devonport at 11.15 p. m., conveying about fifty first-class passengers who had landed from the American liner *New York*. The train consisted of a four-coupled express engine with leading bogie, three first-class corridor-coaches, and a guard's van with kitchen. The arrival of the *New York* at Plymouth was somewhat belated, and consequently a smaller number of passengers than usual elected to leave the vessel at this port of call.

All appears to have gone well with the express until Salisbury was reached at 1.57 a. m. At the eastern end of the station, a curve of ten chains radius is encountered, and at this point the engine of the express left the rails and struck the rear of a milk train, which was slowly entering the station in the opposite direction on an adjacent line. The guard's van of the milk train was totally wrecked, the guard being killed outright. After its impact with this vehicle, the express engine fouled some of the girders of the bridge passing over Fisherton Street, and then crashed into a stationary locomotive standing on a further line. Meanwhile, the most dreadful havoc had been wrought on the coaches of the express. The coupling-rod behind the tender broke, the front coach overshot the engine, and, coming into collision with a side of the bridge, was completely shattered, one of the passengers being hurled with a portion of the woodwork into the street below. The second coach swung across the metals, and landed on the top of the express engine, the third coach being flung to the left of the line, where it was smashed to pieces. The fourth coach (consisting of a guard's van and kitchen) was only partially derailed.

The terrible destruction of rolling stock makes it difficult to realise that any lives could have been saved from this appalling wreckage. Some fifty people were involved in the catastrophe, and out of this number, twenty-one were killed outright, while six expired shortly afterwards in the local infirmary from injuries sustained. Out of the total of twenty-seven killed, twenty-three were passengers, while the remaining four were servants of the company. Eleven passengers were injured (six seriously), and only twelve escaped without injury. The boat-train passengers were composed almost entirely of American travellers. The company's servants who lost their lives were the driver and fireman of the express, the guard of the milk train, and the fireman of the stationary locomotive.

Sir Charles Owens (general manager of the South Western Company), Mr. J. W. Jacomb-Hood

(resident engineer), Mr. Henry Holmes (superintendent of the line), and other officials journeyed to Salisbury on Sunday morning, and early in the afternoon the line had been cleared by the breakdown gangs from Nine Elms and other points on the South Western system.

The Board of Trade have appointed Major J. W. Pringle, R.E. (inspecting officer of railways), to hold an inquiry into the cause of the accident. In the meantime anything which tends to elucidate the cause of the accident is of deep interest, and elsewhere in this issue we give a review of the facts after careful scrutiny of the permanent way and an expert opinion based on them.

It is needless to say that everything possible was done for the injured and their friends by the officials of the London and South Western Railway, who were tireless in their efforts. The company has been singularly exempt from serious accidents of the kind, and that the disaster should have befallen one of the most important trains of the line, to which special attention is devoted, makes it abundantly clear that no precaution had been neglected by the company's officials. The exact cause of the accident yet remains to be determined, although various explanations have been given. None of these appeared to us to be satisfactory, and we consequently commissioned a railway engineer of wide experience to investigate the matter. He has supplied the following comment as the outcome of his investigation, and the conclusions which he has reached appear to us to be worthy of serious consideration. The accident which befel the up boat special on Sunday morning just east of Salisbury Station was, says our Commissioner, an extraordinary one. The noise of the shock is described by those who heard it as like the report of a big gun, and it was followed by absolute silence. The whole train was shattered in a few seconds. The curve where the engine was derailed, followed by all the carriages except the last bogie of the guard's van, is a short one, the part having a check rail being only 200 feet long. The line is straight through the main station and again over the bridge, the girders of which finally stopped the onward motion of the vehicles. The curve is a compound or transition one, beginning at about 12 chains or 800 feet radius, and being rather less than 8 chains or a little over 500 feet radius at the sharpest point. The super-elevation of the outer rail is also graduated from *nil* to about 3 1/2 inches, which is quite sufficient for a speed of 30 miles an hour. This was the maximum speed allowed by the running rules, and it was just within the limits of safety. It is easy to be wise after the event, but we think 15 or at most 20 miles an hour would be preferable, especially as drivers with that contempt bred of familiarity are always prone to exceed imposed limits, whether on rail or on road. Check rails on curves are always covered with a thick layer of dirt and grease, which layer would, of course, be distinctly marked even by a slight scratch. Yet the most remarkable fact is that no such scratch or mark was found on the check rail throughout its length. Moreover, the whole of the permanent way in that same length, which is of the latest type, was at the time and is now in perfect order. The only damage done was that two or three chairs of the outer rail had the inner jaws broken, that the outer end of some sleepers were slightly battered, and that the outer rail had been pushed inwards in one or two places. Half an hour's work must have made good these slight defects. The driver was some minutes behind time, and it can scarcely be doubted that he was running over 50 miles an hour at the time of the accident. It is now a recognised fact that engines having a high centre of gravity run more steadily than the old-fashioned type, in which the centre was kept low. Take a stick with a heavy knob and try to balance it with the knob in your hand. You will find that you will have to move your hand about all the time, and with a wide range of movement. Hold the point of the stick in your hand and the knob uppermost, and very little movement is then necessary to preserve the balance. On the other hand, if you allow the knob

to lean over too much it requires a great effort to get it back to the perpendicular. This effort is represented by the centrifugal force in the case under notice. Careful calculations prove that, without doubt, an engine similar to the one on the train would run for some time on its outer wheels alone, and would finally turn over on its side if travelling at 40 miles an hour when going round a curve of 8 chains radius with a superelevation of less than 4 inches. That this is what happened there can be no doubt whatever, as all the facts enumerated above tend to prove, although we are not aware that a similar accident has ever happened before. The falling and fallen engine was shoved about by the following carriages, which were crumpled up in the process, and the weight and size of the obstacle accounts for the way in which the lighter vehicles were knocked into little bits.

---

## NEW BOOKS AND PUBLICATIONS

---

[ 625 .14 (01 & 385. 04 ) ]

CUËNOT (G.), engineer in chief of bridges and roads. — *Étude sur les déformations des voies de chemins de fer et les moyens d'y remédier* (Investigation concerning the deformations of railway tracks and means of obviating them). — 1 volume octavo (23 × 15 centimetres [9 × 6 inches]), 213 pages, with illustrations and an atlas in quarto with 21 plates. — 1905, Paris, V<sup>re</sup> Ch. Dunod, publisher. Price, 12 francs (9s. 7 1/2 d.).

Having been deputed by the Public Works Department to investigate the compound sleepers (steel and wood) of the Devaux, Michel and Richard pattern, Mr. Cuënot, who for five years has been a government inspector on the Paris-Lyons-Mediterranean Railway, determined to carry out his task conscientiously. With this object in view, he proceeded to institute comparisons experimentally between ordinary sleepers and steel sleepers and these led him to "a series of tests bearing upon all the movements to which the track is subject and to a study of all the deformations to which it is liable". He found it advisable to include in his investigation the ways in which the consolidation of the sleepers took place and the subject of rail joints.

Mr. Cuënot's experiments by way of comparison led him to consider quite naturally how best to strengthen the track so as to render it capable of withstanding speeds of 200 kilometres (124 miles) an hour, such as may be expected, to be reached in the future. He believes that for this purpose it will be necessary :

- 1° To use exceedingly rigid sleepers, twice or thrice as rigid as those now commonly employed, and this, he says, would exclude the use of trough-shaped steel sleepers;
- 2° To support the joint by a sleeper followed and preceded at an interval of 50 centimetres (1 foot) by equally rigid sleepers;
- 3° To employ stronger plates.

We may disagree with the author, but his pamphlet which is characterized by its sincerity, will undoubtedly be perused with benefit.

L. W.

---





# List of the papers published for the Fifth Session.

ENGLISH EDITIONS (IN RED COVERS).

NUMBER of the pamphlet.	NUMBER of the Question.	TITLE OF THE QUESTION.	CONTENTS.	PRICE.	
				Excluding postage.	Including postage.
1	XX	Brakes for light railways . . . . .	Report, by Mr. Ploeg . . . . .	FR. C. 1 50	FR. C. 1 60
2	V	Boilers, fire-boxes and tubes . . . . .	Addenda, by the same. . . . .		
3	XVI	Decimal system. . . . .	Report, by Mr. Ed. Sauvage . . . . .	3 "	3 15
4	XIX	Light railway shops . . . . .	— by Mr. J.-L. Wilkinson . . . . .	1 50	1 60
5	XV	The twenty-four hours day. . . . .	— by Mr. Terzi . . . . .	1 50	1 60
6	XIII	Organisation. . . . .	— by Messrs. Scolari and Rocca. . . . .	1 50	1 60
7	X	Station working . . . . .	2 <sup>nd</sup> report (for English speaking countries), by Mr. Harrison. . . . .	1 50	1 60
8	XI	Signals . . . . .	2 <sup>nd</sup> report on parts A and B (for English speak- ing countries), by Mr. Turner . . . . .	2 25	2 40
9	I	Strengthening of permanent way in view of increased speed of trains. . . . .	2 <sup>nd</sup> report (for English speaking countries), by Mr. Thompson . . . . .	2 25	2 40
10	VI	Express locomotives . . . . .	1 <sup>st</sup> note, by Mr. Raynar Wilson. . . . .		
11	II	Places in permanent way requiring special atten- tion. . . . .	2 <sup>nd</sup> report (for English speaking countries), by Mr. William Hunt . . . . .	3 "	3 20
12	XIII	Organisation. . . . .	Addenda by the same. . . . .		
13	VII	Rolling stock for express trains . . . . .	Report, by Mr. Aspinall. . . . .	7 50	7 90
14	III	Junctions. . . . .	— by Mr. Sabouret . . . . .	1 50	1 60
15	...	The history, organisation and results of the Inter- national Railway Congress. . . . .	1 <sup>st</sup> report (for non-English speaking countries), by Mr. Duca . . . . .	9 "	9 40
16	IX	Acceleration of transport of merchandis . . . . .	Report, by Mr. C.-A. Park. . . . .	2 "	2 10
17	XII	Cartage and delivery. . . . .	— by Mr. Zanotta. . . . .	3 "	3 15
18	XI (See also N° 8)	Signals . . . . .	Note, by Mr. A. Dubois. . . . .	2 50	2 65
19	XVII-A	Light feeder lines (contributive traffic). . . . .	Report, by Mr. H. Lambert . . . . .	1 50	1 60
20	XIV	Settlement of disputes . . . . .	Report, by Mr. H. Twelvrees . . . . .	1 50	1 60
21	XVIII	The working of light railways by leasing com- panies. . . . .	1 <sup>st</sup> note, by the Belgian State Railways Ad- ministration. . . . .		
22	IV	Construction and tests of metallic bridges . . . . .	2 <sup>nd</sup> note, by the Western Railway of France Administration. . . . .		
23	X	Station working. (Methods of accelerating the shunting of trucks.) . . . . .	1 <sup>st</sup> Report (for non-English speaking countries), by Mr. Motte. . . . .	3 75	3 95
24	...	Railway progress in the Dominion of Canada . . . . .	2 <sup>nd</sup> note, by the Mediterranean Railway Company (Italy). . . . .		
25	I (See also N° 9)	Strengthening of permanent way in view of increased speed of trains. . . . .	3 <sup>rd</sup> note, by Mr. Theo.-N. Ely. . . . .		
26	XVII-B	Relaxation of normal requirements for light rail- ways. . . . .	4 <sup>th</sup> — by the American Railway Association (Messrs. A.-W. Sullivan and F.-A. Delano). . . . .		
27	VIII	Electric traction . . . . .	5 <sup>th</sup> note, by Mr. Robert Pitcairn. . . . .		
28	XIV (See also N° 20)	Settlement of disputes . . . . .	6 <sup>th</sup> — by Mr. A.-T. Dice. . . . .	1 50	1 60
29	I (See also N° 9 and 25)	Strengthening of permanent way in view of increased speed of trains. . . . .	Report, by Mr. De Backer. . . . .	1 50	1 60
30	A	Technical information on the breaking of steel rails. — on the current cost of metal- lic compared with wooden sleepers. . . . .	— by Mr. De Perl. . . . .	3 75	3 95
31	B	Technical information on the life of wooden sleepers of different kinds, not pickled or pickled according to various processes. . . . .	— by Mr. de Burlet . . . . .		
32	C	Technical information on locomotive crank axles. . . . .	Note, by Mr. W.-M. Acworth. . . . .	4 50	4 75
33	D	— on locomotive fire-boxes . . . . .	Report, by Mr. Max Edler von Leber. . . . .	6 "	6 30
34	E	— on locomotive boilers . . . . .	1 <sup>st</sup> report on Part A (for non-English speaking countries), by Mr. J. de Richter . . . . .		
35	F	— on the lubrication of rolling stock. . . . .	1 <sup>st</sup> report on Part B (for non-English speaking countries), by Messrs. Eug. Sartiaux and A. von Boschan. . . . .		
36	G	Technical information on shunting engines and on the movement of the staff in different coun- tries. . . . .	1 <sup>st</sup> note, on Part B, by Mr. Ast 2 <sup>nd</sup> — by the Administration of the "Kaiser Ferdinand Nordbahn". . . . .	1 50	1 60
37	H and I	—	Memorandum, by the Hon. Sir Charles Tupper. Report, by Mr. Ast (first part). . . . .	2 25	2 40
38		—	Report, by Messrs. Humphreys-Owen and P.-W. Meik. . . . .	3 "	3 15
39		—	1 <sup>st</sup> note, by Mr. E.-A. Ziffer. . . . .		
40		—	2 <sup>nd</sup> — by the Hon. Thomas C. Farrer. . . . .		
41		—	Report, by Mr. Auvert . . . . .	6 50	6 80
42		—	1 <sup>st</sup> note, by the Western of France Railway. . . . .		
43		—	2 <sup>nd</sup> — by the Northern of France Railway. . . . .		
44		—	3 <sup>rd</sup> — by Mr. Ernest Gerard . . . . .		
45		—	Note, by Mr. Chas. J. Owens. . . . .	1 50	1 55
46		—	Report, by Mr. Ast (second part). . . . .	3 50	3 70
47		—	Report, by Mr. Bricka . . . . .	1 50	60
48		—	— by Mr. Kowalski . . . . .	3 "	
49		—	— by Mr. V. Herzenstein . . . . .	7 "	
50		—	As the information collected on this question was very incomplete, it was not dealt with. . . . .		
51		—	Report, by Mr. Hodeize. . . . .	6 "	6 50
52		—	— by Mr. Belleruche . . . . .	3 50	3 70
53		—	— by Mr. Hubert . . . . .	3 50	3 70
54		—	As the information collected on these questions was very incomplete, it was not dealt with. . . . .		

N. B. — The numbering of the pamphlets (see first col.) issued in French and English is not the same. The English editions are in red covers and the French editions in brown covers.

CONTENTS.	PAGES.	NUMBERS OF PLATES AND FIGURES.	NUMBERS of the DECIMAL CLASSIFICATION.
I. — NOTE on the steam production of locomotive boilers, by O. BUSSE . . . . .	1185	...	621 .133 (01
II. — Table of speeds, by Henri de SARRAUTON . . . . .	1188	Figs. 1 and 2, p. 1188.	656 .222.1
III. — NOTE on the metal screw bushes for strengthening rail fastenings, on the Thiollier system, by X*** . . . . .	1192	Figs. 1 to 7, pp. 1192 to 1201.	625 .143.5
IV. — THE Westinghouse electro-magnetic brake, by Rudolf BRAUN.	1203	Figs. 1 to 25, pp. 1205 to 1216.	625 .255
V. — FINAL results of the Simplon tunnel survey, by Dr. M. ROSEN- MUND . . . . .	1220	Fig. 1, p. 1221.	625 .13
VI. — PROCEEDINGS OF THE SEVENTH SESSION (2 <sup>nd</sup> section, locomotives and rolling stock) :			
Question VI : Pooling locomotives. Sectional discussion. Report of the 2 <sup>nd</sup> section. Discussion at the general meeting. Conclusions . . . . .	1227	...	621 .137.3
Appendix : Corrigenda to the report No. 3, by E. HUBERT.	1260	...	...
Question VII : Automatic couplers. Sectional discussion. Report of the 2 <sup>nd</sup> section. Discussion at the general meeting. Conclusions . . . . .	1261	...	625 .216
Appendix I : Addenda to report No. 1 (England, by William F. PETTIGREW . . . . .	1309	Figs. 15 to 19, pp. 1311 to 1315.	625 .216
— II : Note on the Boirault automatic car coupler.	1317	Figs. 1 to 9, pp. 1319 to 1322.	625 .216
VII. — MISCELLANEOUS INFORMATION :			
1. Automatic signals in Great Britain and on the Continent.	1324	...	656 .256.3
2. Comparative test of large locomotive air pumps . . . . .	1328	Figs. 1 to 7, pp. 1332 and 1333.	621 .135.5 (.01
3. Weighbridge for determining the loads of the different wheels of locomotives and other rolling stock, with common raising mechanism, on the Zeidler system . . . . .	1335	Figs. 5 to 12, pp. 1336 to 1338.	656 .212.8
4. Whitewashing car used on the Central London Railway.	1339	Fig. 13, p. 1339.	625 .245
5. Experimental track for trials of superstructures and ballast. . . . .	1340	Fig. 14, p. 1340.	62. (01 & 625 .1 (01
6. The accident at Salisbury . . . . .	1341	...	656 .281
VIII. — NEW BOOKS AND PUBLICATIONS :			
Étude sur les déformations des voies de chemins de fer et les moyens d'y remédier. Investigation concerning the deformations of railway tracks and means of obviating them, by G. CUENOT . . . . .	1344	...	625 .14 (01 & 385. (04
IX. — MONTHLY BIBLIOGRAPHY OF RAILWAYS :			
I. Bibliography of books . . . . .	77	...	016 .385. (02
II. — of periodicals . . . . .	79	...	016 .385. (05

YEARLY SUBSCRIPTION (Jan. to Dec. only) PAYABLE IN ADVANCE, £1.4s. — \$6.

Vol. XX. — No. 9. — September, 1906. 11<sup>th</sup> Year of the English Edition.

# BULLETIN

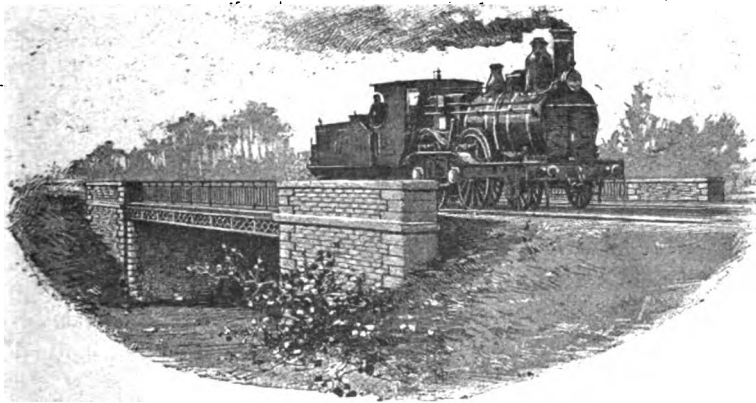
OF THE

# INTERNATIONAL RAILWAY CONGRESS

## ASSOCIATION

(ENGLISH EDITION)

[ 385. (05) ]



Editorial communications should be addressed  
to the Permanent Commission (Executive Committee) of the International Railway Congress Association  
rue de Louvain, 11, Brussels.

BRUSSELS  
PUBLISHED BY P. WEISSENBRUCH, PRINTER TO THE KING  
49, rue du Poinçon.

LONDON  
P. S. KING AND SON, PARLIAMENTARY AND GENERAL BOOKSELLERS  
2 and 4, Great Smith Street, Westminster, S. W.

The Permanent Commission of the Association is not responsible for the opinions expressed  
in the articles published in the BULLETIN.

# NOTICE

---

All editorial communications intended for the *Bulletin* should be addressed to Mr. Louis Weissenbruch, General Secretary of the Permanent Committee, International Railway Congress Association, 11, rue de Louvain, Brussels. The *Bulletin*, which is published in monthly numbers forming an annual volume of more than 800 pages, contains the whole of the proceedings and publications of the Congress of every kind. Copies are sent gratuitously to all the Companies, members of the Congress, at the rate of one copy for each delegate which the Company is entitled to send to a Congress meeting with one extra copy for the Company's own library.

The *Bulletin* can be supplied at the rate of 25 francs = £1 = \$5 per annum, not including postage; or 30 francs = £1.4s. = \$6 including postage to subscribers who send their subscriptions in advance by cheque or postal order direct to the publisher, Paul Weissenbruch, 49, rue du Poinçon, Brussels.

---

*N. B.* — The annual subscription, which must be paid in advance and dates from the January of the year for which the subscription is sent, does not vary even when the number of pages in the year's issue greatly exceeds 800 pages (the 1900 volume of the English edition consisted of 3988 pages). But the price of each monthly number, if bought separately, is fixed according to the number of pages it contains as follows :

2s. (50 cents) per 72 pages not including postage.

It is therefore evident that there is a great gain in subscribing for the whole year.

---

The whole years 1896, 1897, 1898, 1899, 1900, 1901, 1902, 1903, 1904 and 1905 of the English edition of the *Bulletin* containing 1,370, 1,824, 1,634, 1,695, 3,988, 2,734, 1,129, 1,353, 2,066 and 2,626 pages, may be obtained each at 35 francs = £1.8s. = \$7, including postage.

---

Previous volumes of the *Bulletin*, published in French only, contained 1,574, 1,196, 2,194, 1,576, 749, 4,114, 1,124, 1,118, 3,812 and 1,632 pages, illustrated with numerous plates and diagrams, for the years 1887 to 1896 respectively may be obtained at the same price.

---

PAPERS PUBLISHED FOR THE FIFTH SESSION : A detailed list of the papers, notes, and technical information, prepared for the London meeting, is given on the third page of the cover.

Copies may be had on application to the publisher, 49, rue du Poinçon, enclosing remittance of the price as given in the list opposite each paper on the third page of the cover. (*N. B.* 1 franc = 10d. = 20 cents.)

BULLETIN  
OF THE  
INTERNATIONAL RAILWAY CONGRESS  
ASSOCIATION  
(ENGLISH EDITION)

---

[ 621 .133.2 ]

NOTE  
ON THE TIGHTNESS OF FOUNDATION RINGS,

By O. BUSSE,

LOCOMOTIVE AND ROLLING STOCK SUPERINTENDENT, DANISH STATE RAILWAY.

---

We have often heard locomotive engineers state that the foundation ring is the weak point in connection with locomotive boilers. By this we do not mean that there is any danger as regards the strength of foundation rings, but there is trouble in keeping the joints tight and preventing corrosion from resulting through leaks. Leaks soon begin to develop, more especially at the corners; and no subsequent caulking will radically cure them. Now what has been done to reduce the chance of leakage? The single row of rivets originally used has been replaced by two or even three rows; the rings have been deepened at the corners and their width reduced, so that they only form a connection with the outer shell.

This arrangement (shown on page 170 of *Die Eisenbahn-Technik der Gegenwart*), is good, but when it was necessary to use forged iron, it had the disadvantage of being somewhat expensive. This however is no longer the case, as it can now be cast in steel, and therefore this system is worth examining. It is well known that a double row of rivets does not give satisfactory results; on the other hand, I observed some years ago on a number of our locomotives that a single row of rivets gave a good tight joint. This observation led me to consider the subject, and make experiments, and on a number of boilers I used a single row of rivets for the foundation ring; and I certainly had no reason to regret it.

I considered the matter from two points of view: firstly, what was the cause of the leaks, and secondly, is a single row of rivets strong enough?

When the rivets are being put in and closed, the material immediately round the rivet-hole is subjected to stress. The greater the number of rivets, the greater the

resulting stresses; and these stresses have most effect at the weakest places, that is at the corners, where the rivets are sometimes far apart and where it is sometimes necessary to use studs and nuts, because there is no room for rivets. This effect is, it is true, reduced by putting the rivets in first at the corner, then at the middle, and so on alternately, in order to distribute the stresses. But in spite of this, stresses are produced, and the greater the number of rivets, the greater the stresses. Moreover, when a double row of rivets is used and the rivets are further apart in the lower row, the plate is held less tightly against the ring; consequently caulking is not so effective as when there is a single row of rivets with the rivets closer together. It follows that the small particles of scale which come down, more readily affect the plate. Once the water has worked through to the caulking, leaks start, and rusting and corrosion; and serious damage soon results.

Thus double riveting is a disadvantage from the point of view of tightness. It remains to be considered whether single riveting gives sufficient strength.

In considering this point, I will assume that the fire-box has to stand a pressure of 15 kilograms per square centimetre (213·34 lb. per square inch), that the ring is 100 millimetres ( $3\frac{15}{16}$  inches) wide, and that the rivets are to have 26 millimetres ( $1\frac{1}{32}$  inch) diameter and 65 millimetres ( $2\frac{9}{16}$  inches) pitch. The tensile and shearing stresses to which individual rivets are subjected require consideration, and also the tensile stresses on the boiler plate. The load between each pair of rivets is  $10 \times 6\cdot5 \times 15 = 975$  kilograms (2,150 lb.), and the cross-section of a rivet is 531 square millimetres (0·823 square inch); consequently, the shearing stress is equal to  $\frac{975}{2 \times 531} = 0\cdot918$  kilogram per square millimetre (1,306 lb. per square inch).

The boiler plate between the rivets is assumed to be 17 millimetres ( $\frac{43}{64}$  inch) in thickness, which gives a cross-section of  $17 \times (65 - 26) = 663$  square millimetres (1·028 square inch). The stress thus is  $\frac{975}{2 \times 663} = 0\cdot735$  kilogram per square millimetre (1,045 lb. per square inch), which is very low, even for copper.

The tensile stress on a rivet is equal to the pressure of the steam on the boiler plate from the lower row of stays to the row of rivets, say 100 millimetres ( $3\frac{15}{16}$  inches); this multiplied by the width of 65 millimetres ( $2\frac{9}{16}$  inches) and the boiler pressure gives :

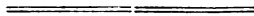
$$10 \times 6\cdot5 \times 15 = 975 \text{ kilograms (2,150 lb.)}.$$

The tensile strength is thus  $\frac{975}{531} = 1\cdot84$  kilogram per square millimetre (2,617 lb. per square inch).

Thus the total stresses on a rivet, if added together, only amount to  $0\cdot918 + 1\cdot84 = 2\cdot758$  kilograms per square millimetre (3,923 lb. per square inch); if we calculate out the resultant of these stresses accurately, we obtain 2·44 kilograms per square millimetre (3,470 lb. per square inch).

It follows that the resulting stresses by no means make it necessary to have two rows of rivets; and as it has been above shown that double riveting is a disadvantage as regards tightness, it is advisable to abandon the practice.

On the grounds of practical results as well as of theory, I can therefore recommend foundation rings with a single row of rivets and deepened at the corners, the outer shell being fixed to the ring, at those points, by about eight rivets.



## WHEEL CARRYING RAIL JOINTS AND TIE PRESERVATION,

By MAX BARSCHALL.

Figs. 1 to 8, pp. 1350 to 1353.

The *Zentralblatt der Bauverwaltung* announced the uselessness of the Stossfangschiene (Barschall Rail Joint) in an article reproduced in the *Bulletin of the Railway Congress* of May, 1904. It may, therefore, be permitted to refer through the same medium to the *Kaufmännischer Beitrag zur Lösung der Schienenstossfrage, 1902-05* (Gutenberg Verlag, Berlin W 35) which contains the details in regard to the aggressive proceedings of the Berlin Ministerium of Railroads, tending to discredit wheel-carrying joints, and which also contains exact information on the facts of the development of this class of joints in Europe and in the United States.

In 1898, Dr. Zimmermann (*Zentralblatt der Bauverwaltung*, February 26) and Ministerialcommissar Schröder (Session of the Prussian Diet, March 24) condemned the theory as being altogether wrong — a view exactly contradictory to that held by the Saxony State Railroads and by a number of Prussian Railroad Administrations — and this was followed up by the issue of a ministerial order in the *Eisenbahn Verordnungsblatt* prohibiting the further use of the Stossfangschiene and thus preventing the Prussian administrations from practically proving the incorrectness of their superiors' theory by ordering and using the correct shape (rolled, width of running surface 20 millimetres [ $\frac{25}{32}$  inch] only).

The construction was again attacked in 1903 (*Zentralblatt der Bauverwaltung*, November 11), which only goes to show that, after five years, it was of sufficient importance to not have wholly dropped from the minds of those who opposed it. This attack, purported to show the impracticability of the construction, was supported by official sources, which referred to results obtained from a make-shift of said joint, which of course were hardly satisfactory. It is not too much to say that these results have lost their value, as regards final conclusions, since the full efficacy of the joints was clearly shown by tests, with correctly formed and rolled (not hand-made) joints, by other railroads.

The article was bound to mislead, on account of the reticence of the Vienna Railroad, Kaschau-Oderberger Railroad and Grossherz. Mecklenburg. Friedrich Franz Railroad, to officially publish their reports on their experience with the rolled form, running width 20 millimetres ( $\frac{25}{32}$  inch), on about 150 kilometres (93 miles) of track.

The experience of the latter road is especially important, because it confirms the progress and advantage gained by equipping worn rail ends with the Stossfangschiene. (See *Railroad Gazette*, December 16, 1904, p. 645.)

A copy of the verdict of the German Supreme Court, rejecting the official attack

on the Stossfangschiene patents, was recently added to the abovenamed pamphlet because :

1° It contains the unsatisfactory experience on 3 kilometres (1·86 mile) of track of the Kaiser-Ferdinands Nordbahn with *rolled* joints, width of running surface 25 millimetres ( $\frac{31}{32}$  inch), and the satisfactory experience on 90 kilometres (56 miles) of track of the Vienna Railroad with the same joint, running width 20 millimetres ( $\frac{25}{32}$  inch) only;

2° It confirms the new technical efficacy of the construction, on the basis of the experience gained with the *narrower* shape;

3° The arguments pro and con expressed by the experts, Messrs. Ast and Koestler, indicate what remains to be improved on the new technical efficacy, mainly to be secured by independent deflection of the suspended parallel bearers and the shape of the head of the Stossfangschiene.

The pamphlet also contains full particulars on the outcome of the tests on the tracks of the Pennsylvania Railroad and of the Pennsylvania Lines West of Pittsburgh. Unhappily these tests were made with the same inferior form as had been used in the Prussian tests, so that the latter came to the conclusion that, after six years experience, the tests of the rolled joints could not be dispensed with in order to arrive at final conclusions, as expressed by their former Vice-President, Mr. L. F. Loree, in an article of the *Railroad Gazette* of March 8, 1901. The article explains fully the reasons and aims of the tests and closes with the words, "If in the course of four or five more years of determining and classifying facts, and reasoning upon them, we are enabled to substantially improve the joint, we shall have ample reason to be satisfied with our labours".

In the meantime, while the Pennsylvania Lines was waiting to resume the tests with the rolled form of the Barschall joint, the author set himself to continue his labours toward further improvements.

He recently came to the conclusion that the parallel parts forming one joint, must act as though the rail were severed vertically into two alternate parts, and these parts rigidly fastened over the ties when the inner one alone is intended to carry, and unfastened between the ties when both are intended to carry, and be independently and *freely* deflected.

In equipping worn tracks, the outer bearer requires the full carrying capacity of the main rail and a running surface of maximum width; with new and comparatively stiff rails, the reverse is required because the outer bearer is intended to make up for the lack of rigidity of the ends only, and to protect them from being battered. The most important aim, therefore, must be to practically determine the minimum limit of running width and the maximum limit of elasticity of the outer bearer in order to prevent badly worn wheels from being lifted, and thus deteriorating the joint. Equal wear of rail ends and of the outer bearer will prove that the joints act as required by the different shapes of tires.

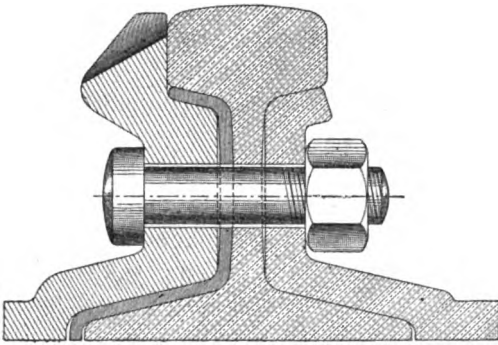


Fig. 1a. — Section over the joint ties.

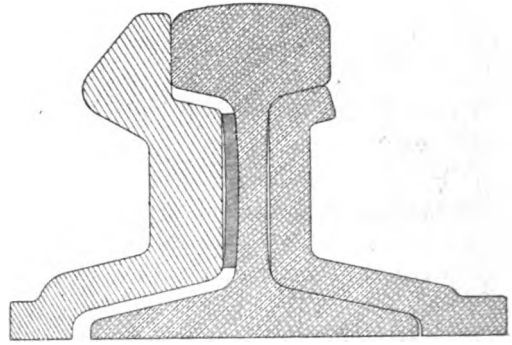


Fig. 1b. — Section between the joint ties.

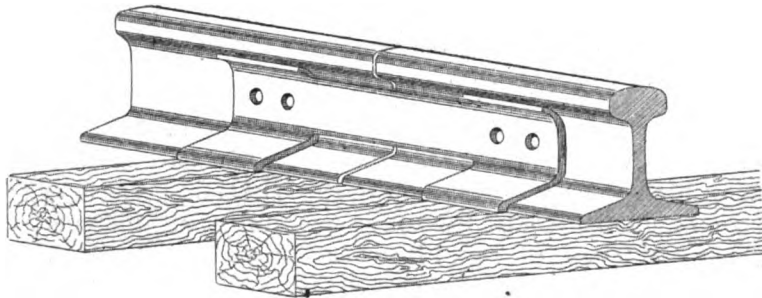


Fig. 1c.

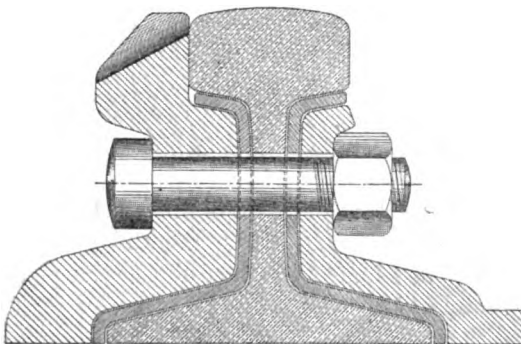


Fig. 2a. — Section over the joint ties.

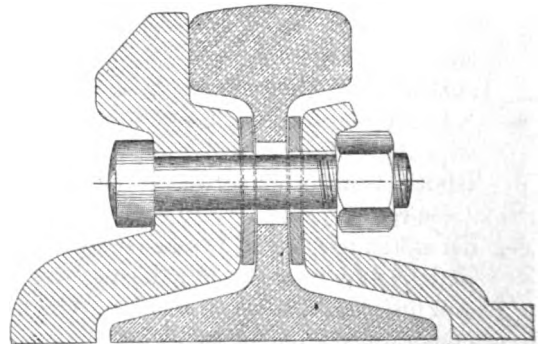


Fig. 2b. — Section between the joint ties.

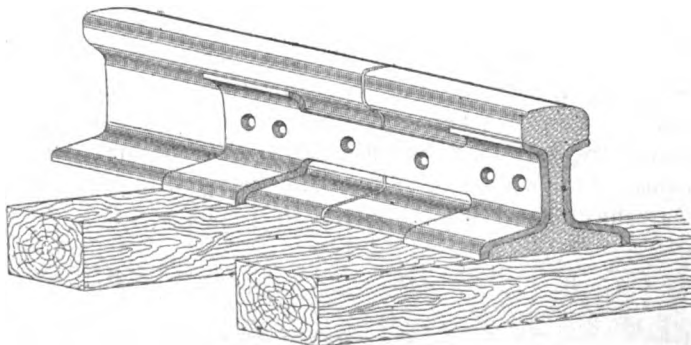


Fig. 2c.

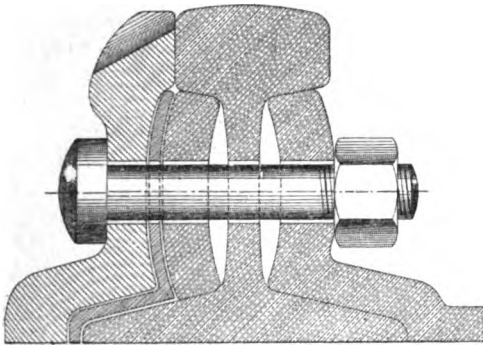


Fig. 3a. — Section over the joint ties.

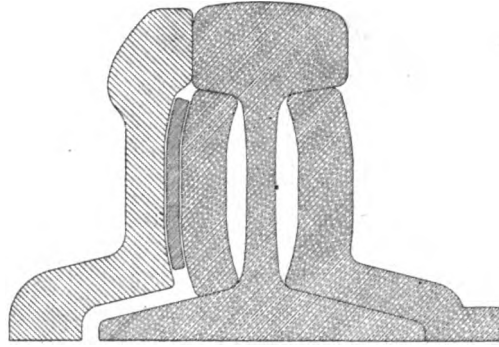


Fig. 3b. — Section between the joint ties.

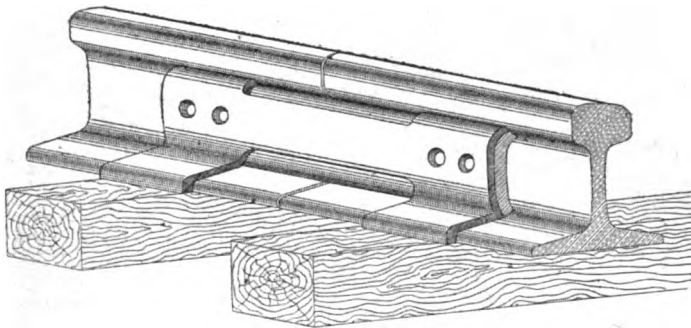


Fig. 3c.

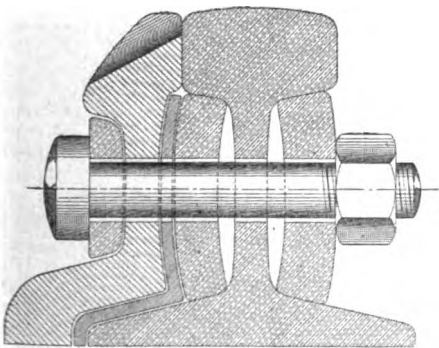


Fig. 4a. — Section over the joint ties.

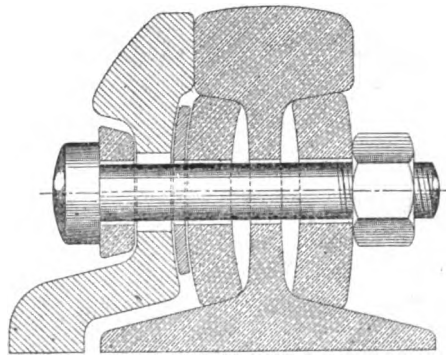


Fig. 4b. — Section between the joint ties

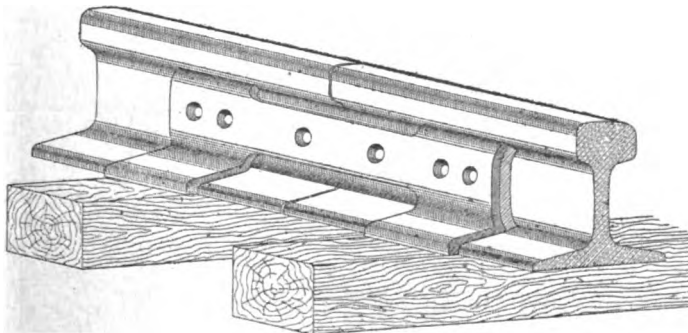


Fig. 4c.

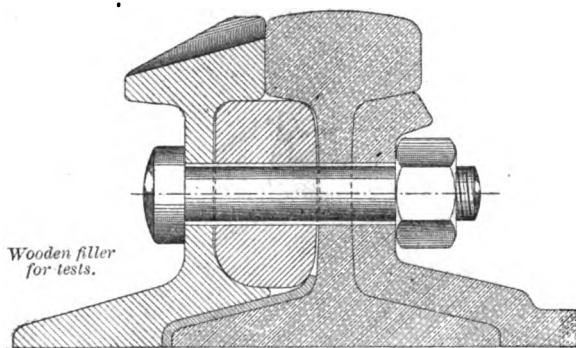


Fig. 5a. — Section over the joint ties.

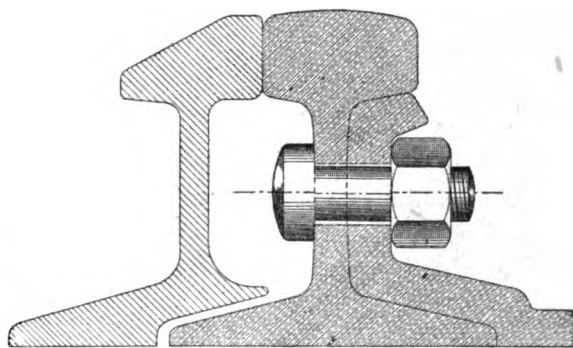


Fig. 5b. — Section between the joint ties.

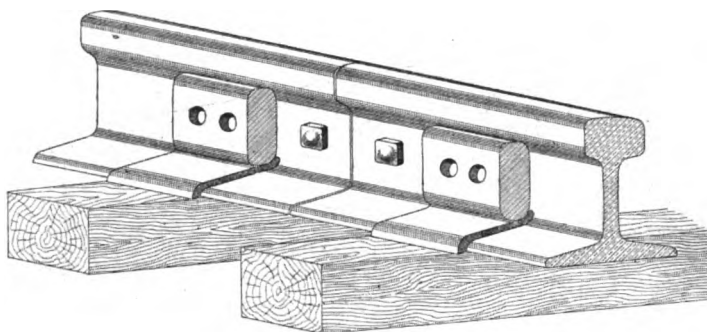


Fig. 5c.

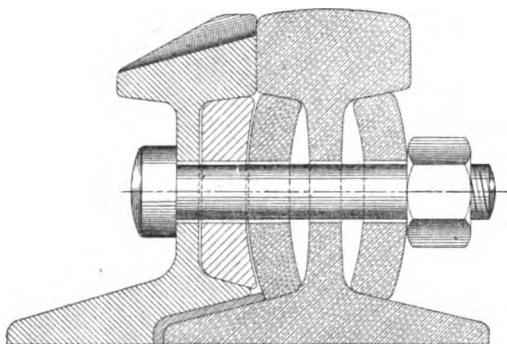


Fig. 6a. — Section over the joint ties.

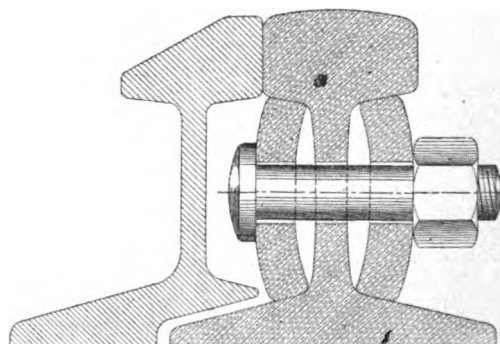


Fig. 6b. — Section between the joint ties.

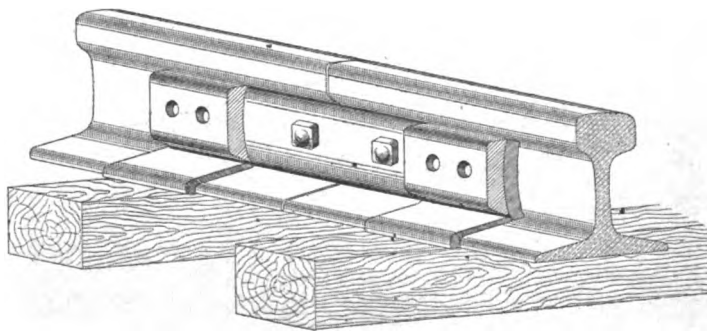


Fig. 6c.

Fig. 7a. — Section over the joint ties.

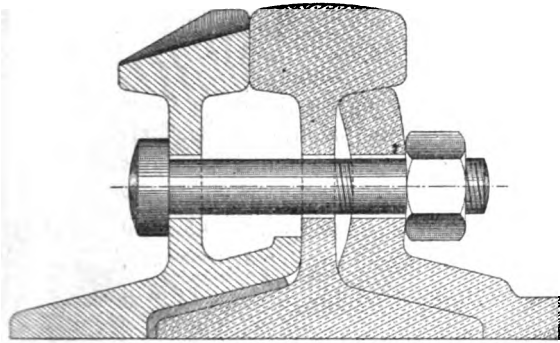


Fig. 7b. — Section between the joint ties.

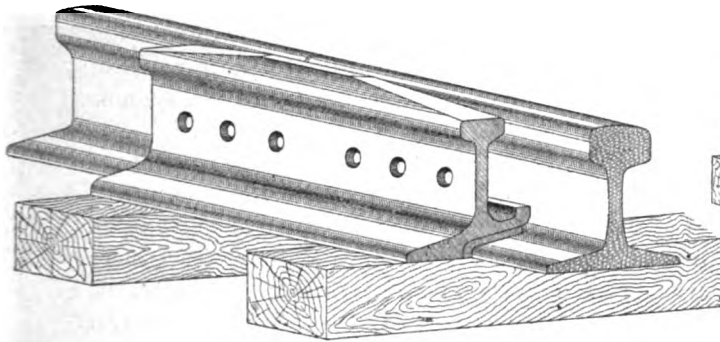
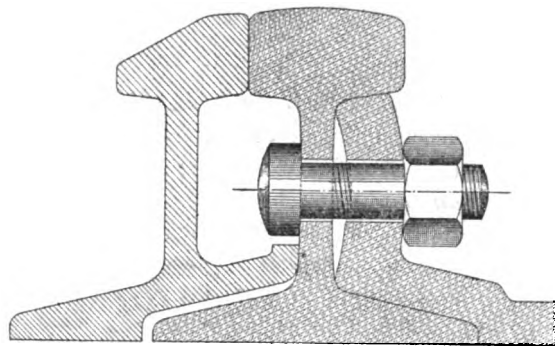


Fig. 7c.

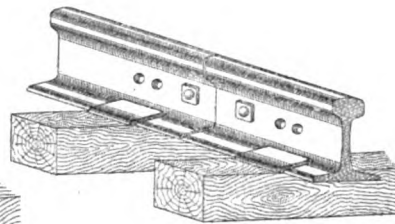
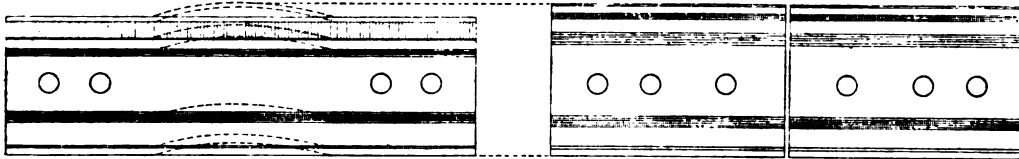


Fig. 7d.

Rolled outer bearers.  
----- Curving of suspended part.

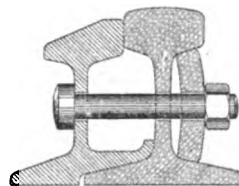
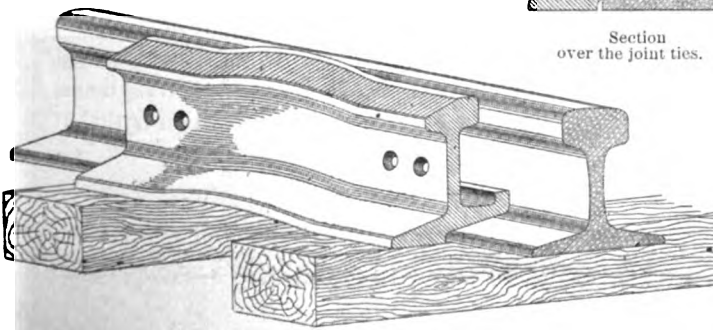
Fig. 8.

Main rail.

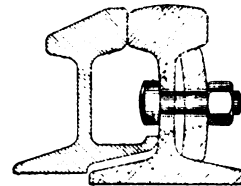


Replacing flange plates and bevelling of ends.

Figs. 7 and 8 combined.



Section  
over the joint ties.



Section  
between the joint ties.

No bevelling of ends, no fillers, no flange plates.

Figures 1 to 8 are intended to demonstrate the course of the author's ideas concerning his new method for applying wheel-carrying joints (patents applied for).

It may be fairly expected that the life of rails will be lengthened until worn out from end to end by the use of wheel-carrying joints, and this calls for a corresponding lengthening in the life of crossties. Recent experience with wooden tie plates indicates that the mechanical wear of ties may be prevented for many years, whilst protection from decay can only be sufficiently secured by saturating them with creosote.

The many efforts recently made to lessen the quantity of creosote required for saturation proves clearly two facts, namely : the unwillingness of the railroads to incur the expense of saturation, and their hesitancy to risk the outcome of employing other antiseptics. It is evident that the risk of using a method lacking practical experience, is proportionate to its cost, and therefore the cheapest of new systems requires to be tested first.

Although considerable progress has been made in treating ties with sulphate of iron and sulphate of aluminæ, it has been shown that these experiments were a failure for the sole and only reason that the formation of free mineral acid and its destructive influence on the woody fibre could not be prevented. In 1904, engineer K. H. Wolman, succeeded in overcoming this last objection, and in consequence, the situation is radically changed, as is indicated in a letter of the Imperial German Patent Office in granting the patent. The many objections made to this grant, contributed greatly to show up the importance of the invention.

This letter after mentioning the general adaptability of the system, says (literally translated), " the inventor adds to the usual solutions of pure metal salts, such salts of organic acids which, like acetates, are able to bind liberated and destructive mineral acids in the timber, and at the same time separate equivalent quantities of inoffensive organic acids, thus preventing decay ".

It has been ascertained that sulphate of aluminæ slowly and steadily hardens the timber and increases its resistance to pressure, whilst the combustibility of such treated timber is considerably reduced.

The new system was started in the mining district of Upper Silesia, where in a number of places creosoting has been abandoned. The cost is said to be, 1·40 marks per cubic metre (0·48*d.* per cubic foot). Comparative tests of timber treated with metal salts and of that treated with creosote, have been made in order to practically determine the superior system in regard to antiseptic capacity and cost; the Wolman tests in this case were made with 8 and 16 kilograms, respectively, of sulphate of iron per cubic metre (0·5 and 1 lb. per cubic foot) and also other tests were made in which like portions of sulphate of zinc were used. Other efforts toward increasing the anti-combustible capacity of timber so treated, have resulted in a special prescription for timber used for many kinds of construction on land and water. The process has many promising features, not the least of which is that it is founded on a scientific basis.

---

## NOTE

### ON DETERMINING THE POWER OF LOCOMOTIVES BY MEANS OF THE SPEED CURVES,

By Dr. KARI SCHLÖSS,

ENGINEER.

---

Figs. 1 to 6, pp. 1357 to 1364.

---

*(Zeitschrift des österreichischen Ingenieur- und Architekten-Vereines.)*

---

*(Abstract.)*

---

The tractive effort which a locomotive can develop depends, as is well-known, on several factors, the importance of which varies with the speed. During the start, that is to say at low speeds, it is principally the adhesive weight of the locomotive, together with the force which the pressure of the steam in the cylinder can produce at the tread of the wheels, on which the power of the locomotive depends. As soon, however, as a certain speed has been attained, the chief factor is the amount of steam the boiler can generate.

But the amount of steam which the boiler of a given locomotive can generate, is not a constant quantity. It depends not only on the size of the grate area and of the heating surface and on various peculiarities in the construction, but also on the quality of the fuel and on the draft, the latter varying with the pressure of the exhaust steam and the speed; it is generally greater per square metre of grate area or heating surface when running fast than when running slow.

A simple method giving sufficiently accurate results, and based on the theoretical considerations enunciated later on, makes it possible to determine the power developed by locomotives, by means of the curves recorded on strips of paper by speed gauges. It may be remarked that it is not possible to measure accurately the power developed by a locomotive during a given run, not even if indicators are fixed to the cylinders; for the accuracy of the diagrams obtained is very doubtful, particularly at high speeds, and moreover, in order to obtain the useful horse-power, sundry corrections have to be applied which have to be determined empirically and therefore cannot be absolutely correct in every individual case.

As regards determining the power by means of speed diagrams, it has first of all to be noted that the resistance of each train depends on a large number of variable factors (such as the number



as  $\mu = 19$  millimetres ( $\frac{3}{4}$  inch) and as 1 minute is represented by 4 millimetres ( $\frac{5}{32}$  inch); consequently :

$$\frac{160}{216 \times 19} = \frac{E - R}{M}.$$

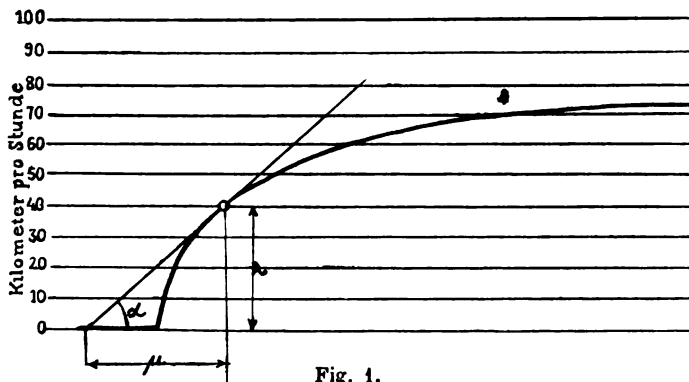


Fig. 1.

*Explanation of German terms : Kilometer pro Stunde = Kilometres per hour.*

Let us assume that the total weight of the train  $W = 60 + 25 + 150 = 235$  tons (231 English tons), and that the section in question is on a rising gradient of 15 per mil. Then :

$$R = \left( 2.4 + \frac{1,600}{1,060 + 320} + 15 \right) 235 = 4,362 \text{ kilograms (9,617 lb.)},$$

and

$$M = \frac{235,000}{9.81} = 23,955.$$

Whence

$$E - R = \frac{160}{216 \times 19} \times 23,955 = 934$$

or

$$E = 4,362 + 934 = 5,296 \text{ kilograms (11,676 lb.)};$$

the total train resistance being represented by 4,362 kilograms (9,617 lb.) and the accelerating force by 934 kilograms (2,059 lb.).

Consequently at the speed of 40 kilometres (24.9 miles) per hour, the power developed by the locomotive will, according to the well-known formula, be

$$P = \frac{E \cdot V}{270} \dots \dots \dots (3)$$

$$P = \frac{5,296 \times 40}{270} = 784 \text{ horse-power (773 British horse-power).}$$

This method thus allows the power at any given moment to be calculated from the speed curves; it will also enable us, by means of the same data, to determine the maximum power of a locomotive, on the hypothesis we are now going to consider.

By means of trial runs, or in the course of ordinary runs, it is possible to determine, for any given locomotive burning a given fuel, the load which it can haul on a given gradient at a given speed, while keeping up the steam-pressure and the amount of water in the boiler to the required level.

Given this power limit, it is possible, by means of the speed curves recorded during a given run, to determine the maximum power developed by the locomotive in question burning the given fuel and running at the given speed.

We stated at the beginning, that during the start, the chief factor on which the tractive effort depends is the adhesion, not the amount of water the boiler can evaporate.

This tractive effort, which can be determined by multiplying the adhesive weight by the coefficient of friction between the wheels and the rails (if the rails are dry, this coefficient varies between  $\frac{1}{8}$  and  $\frac{1}{6}$ ), is always smaller than the force produced at the tread of the wheels, by the mean pressure in the cylinders, if the regulator is wide open and the cut-off as late as possible. Much more so is this therefore the case, when the cranks are in the positions in which the tangential force is a maximum. Consequently, if at starting the regulator were fully opened, the wheels would at once slip on the rails. Therefore, the regulator is only opened a little at first, and then more by degrees, the valve gear being set at the same time for an earlier cut-off.

Consequently at starting, the tractive effort is limited by the friction of the coupled wheels on the rails, whatever may be the tangential force the available pressure on the piston could produce. During that time, the boiler power available is drawn upon to a small extent only, but this amount increases with the speed, and when the latter exceeds a certain limit, the boiler power is the only factor on which further acceleration depends. The change from the influence of the adhesive weight to that of the boiler power is shown, in the speed curves, by a more or less definite alteration in the direction, provided that during the run in question the locomotive has developed power sufficiently uniformly. In the curve shown in figure 2, which was recorded by a Hausschalter speed gauge, this change took place at point A, when the speed was 52 kilometres (32·3 miles) per hour. Beyond this point, the curve ascends more slowly and gradually becomes more of the shape of an asymptote; in other words, it more and more approximates to a certain speed without quite reaching it. The speed at which the change takes place is called the "critical speed"; at this moment, the adhesion and also the evaporative power are completely utilized, and hence there is risk both of the wheels slipping, and of the boiler not generating steam enough to keep up the pressure.

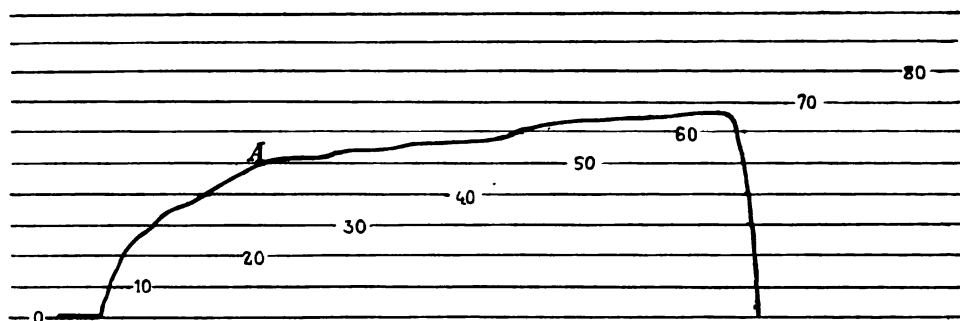


Fig. 2.

In the case of a given locomotive, when the evaporative power of the boiler is known at high speeds, and of a given train of known total weight, there is no difficulty in calculating, by means of equation (2), the speed curve for a given section, and that with great accuracy. For this purpose, we may assume the power of the boiler to be constant, within the limits of speed considered.

For instance, let a four cylinder compound weighing together with its tender 100 tons (98·4 English tons), and having an adhesive weight of 29 tons (28·5 English tons), have a boiler which can, as observations show, develop 1,350 horse-power (1,332 British horse-power) as a maximum. The calculation will then be as follows for a train weighing 300 tons (295 English tons) (total weight of vehicles) running up a gradient of 3·5 per mil :

If the coefficient of friction is  $\frac{1}{8}$ , the initial pull of the locomotive will be :

$$E = 29,000 : 5 = 5,800 \text{ kilograms (12,787 lb.)}$$

As regards the critical speed (as defined above) we have, according to equation (3) :

$$\frac{5,800 \times V}{270} = 1,350, \text{ whence } V = 63 \text{ kilometres (39·1 miles) per hour.}$$

Up to this limit, which only depends on the locomotive, not on the weight of the train or on any other factor, E is constant and equal to 5,800 kilograms (12,787 lb.); beyond it, the power is constant and equal to 1,350 horse-power (1,332 British horse-power); consequently we may take

$$E = \frac{270 \times 1,350}{V}$$

By means of equation (2) we can then calculate, for every additional 10 kilometres (6·2 miles) of speed per hour, the time required for each of these accelerations and the power developed to produce them. The results are given in the following table :

INCREASE OF SPEED, IN KILOMETRES (IN MILES) PER HOUR.	Horse-power developed (British horse-power).	Time necessary for the acceleration, in minutes.
From 0 to 10 kilometres (0 to 6·2 miles) . . .	214 (211)	0·56
— 10 to 20 — (6·2 to 12·4 — ) . . .	429 (423)	0·57
— 20 to 30 — (12·4 to 18·6 — ) . . .	644 (635)	0·60
— 30 to 40 — (18·6 to 24·9 — ) . . .	859 (847)	0·63
— 40 to 50 — (24·9 to 31·1 — ) . . .	1,074 (1,059)	0·69
— 50 to 60 — (31·1 to 37·3 — ) . . .	1,289 (1,271)	0·75
— 60 to 63 — (37·3 to 39·1 — ) . . .	1,350 (1,332)	0·23
— 63 to 70 — (39·1 to 43·5 — ) . . .	1,350 (1,332)	0·81
— 70 to 80 — (43·5 to 49·7 — ) . . .	1,350 (1,332)	2·74
— 80 to 88 — (49·7 to 54·7 — ) . . .	1,350 (1,332)	58·08

These results are shown, plotted as a curve, in figure 3. The resulting line, like an asymptote, comes nearer and nearer to the limiting speed of 89 kilometres (55·3 miles) per hour; that is to say the locomotive in question cannot reach this speed when hauling a train of 300 tons (295 English tons) (total weight of the vehicles) up a gradient of 3·5 per mil, if it develops 1,350 horse-power (1,332 British horse-power). It is at point A of the speed curve that the boiler power becomes the chief factor instead of the adhesion.

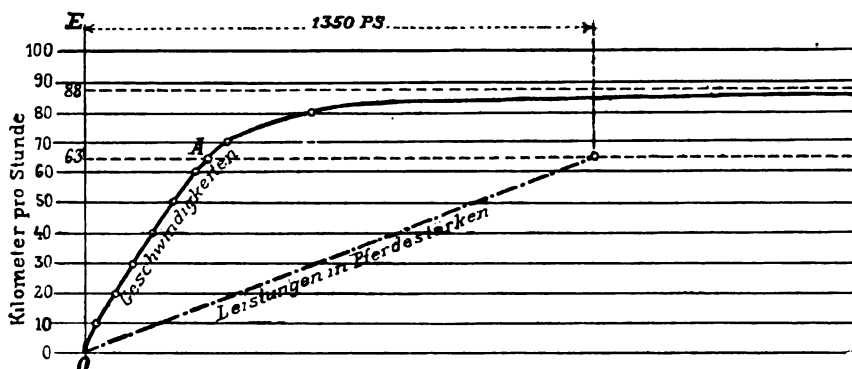


Fig. 3.

Explanation of German terms : Geschwindigkeiten = Speeds. — Leistungen in Pferdestärken = Horse-power developed. — Kilometer pro Stunde = Kilometres per hour. — PS = Horse-power.

The broken line shows the horse-power given by the locomotive at the different speeds, measured from the ordinate OE. At and above 63 kilometres (39·1 miles) per hour the power is constant and equals 1,350 horse-power (1,332 British horse-power), as assumed for the purposes of this calculation.

The speed gauges on locomotives generally record the speed curves as shown in the previous figures, the abscissæ representing the times and the ordinates the speeds in kilometres per hour.

Nevertheless if we desire to work out time-tables by means of the speed curves, it is more convenient to let the abscissæ represent the distances run, as the latter are known for any given section, the ordinates representing the speeds as before.

In equation (1), the term

$$\frac{v_2 - v_1}{t},$$

if referred to an infinitely short time  $dt$ , is identical with

$$\frac{dv}{dt}.$$

If the speed is assumed to be constant during this time, the distance run over will be

$$ds = v \cdot dt$$

or

$$dt = \frac{ds}{v}$$

whence

$$\frac{dv}{dt} = \frac{v \cdot dv}{ds}.$$

Equation (1) then gives, for this time

$$\frac{v \cdot dv}{ds} = \frac{E - R}{M}$$

or, integrating and using the same notation as before :

$$\frac{v_2^2 - v_1^2}{2} = \frac{E - R}{M} \times S \quad \dots \dots \dots (4)$$

$v_1$  and  $v_2$  representing the speed in metres per second, S the distance run while this change of speed takes place.

Let us assume a distance S, in metres, run from the start until the train has attained a speed of V kilometres per hour ( $V = \frac{10}{36} v$ ). Then equation (4) gives :

$$\frac{100 V^2}{2 \times 1,296} = \frac{E - R}{M} \times S$$

whence

$$V^2 = 25.92 \frac{E - R}{M} S \quad \dots \dots \dots (5)$$

and

$$S = 0.0386 \frac{M}{E - R} V^2.$$

This equation enables us, certain assumptions being made, to calculate the time required for running from one station to another. Railways generally make these calculations by means of empirical formulæ which, it is true, are simple, but in many cases give inaccurate results, results which it is either impossible to attain, or which are materially below the maximum limit possible.

Let us again take as example the 300 ton (295 English ton) train hauled up a gradient of 3.5 per mil by a locomotive weighing with its tender 100 tons (98.4 English tons). Equation (5) then gives the following figures :

$$\begin{aligned} \text{For } V = & \left\{ \begin{array}{l} 10 \text{ km., } 20 \text{ km., } 30 \text{ km., } 40 \text{ km., } 50 \text{ km., } 60 \text{ km., } 70 \text{ km., } 80 \text{ km. and } 88 \text{ km. per hour,} \\ 6.2 \text{ m., } 12.4 \text{ m., } 18.6 \text{ m., } 24.9 \text{ m., } 31.1 \text{ m., } 37.3 \text{ m., } 43.5 \text{ m., } 49.7 \text{ m. and } 54.7 \text{ miles per hour,} \end{array} \right. \\ S = & \left\{ \begin{array}{l} 46 \text{ met., } 190 \text{ met., } 447 \text{ met., } 846 \text{ met., } 1,426 \text{ m., } 2,261 \text{ met., } 4,696 \text{ metres, } 14,548 \text{ m. and } 70,070 \text{ metres.} \\ 50 \text{ yards, } 208 \text{ yards, } 489 \text{ yards, } 925 \text{ yards, } 1,560 \text{ y., } 1 \text{ m. } 713 \text{ y., } 2 \text{ m. } 1397 \text{ y., } 9 \text{ m. } 70 \text{ y. and } 43 \text{ m. } 951 \text{ y.} \end{array} \right. \end{aligned}$$

These distances being taken as abscissæ, and the corresponding speeds as ordinates, we obtain the curve shown in figure 4.

If for instance, we wish to determine the time required for running over a section 4.3 kilometres (2.7 miles) long, we must take this as our base OA, draw in the brake line AB as calculated from the brake power available, and determine from the curve OAB the mean speed of running : this amounts, in the case in question, to 52 kilometres (32.3 miles) per hour. The time required for the 4.3 kilometres (2.7 miles) will then be 4.96, in round numbers 5 minutes.

If in the same case, we apply the rule generally used for determining the time required, starting from the fact that the locomotive in question hauling a 300 ton (295 English ton) train up a gradient of 3·5 per mil can attain a speed of 88 kilometres (54·7 miles) per hour, we find, adding half a minute for starting and half a minute for stopping, that the time required is 4 minutes. Now as a matter of fact, this result cannot be attained, as in running the distance in question the maximum speed of 88 kilometres (54·7 miles) is not reached.

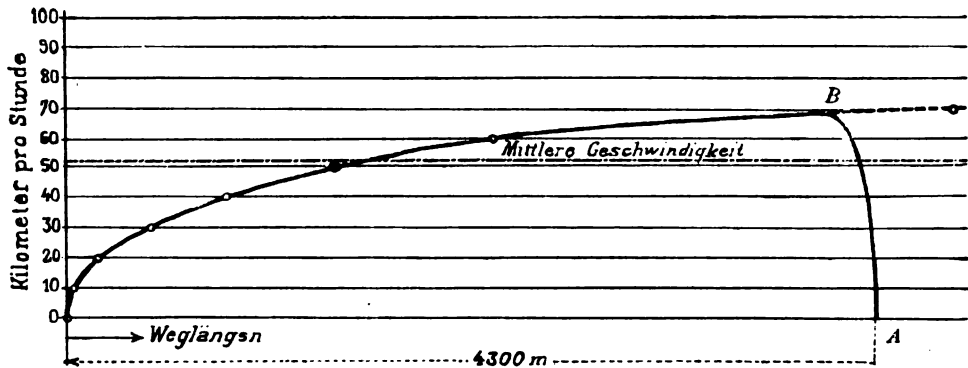


Fig. 4.

Explanation of German terms : Mittlere Geschwindigkeit = Mean speed. — Weglängen = Distances run.  
Kilometer pro Stunde = Kilometres per hour.

We have assumed in the preceding calculations, that the coefficient of friction between wheel and rail is between  $\frac{1}{5}$  and  $\frac{1}{6}$ . That this assumption is practically correct can also be shown by means of the speed curves.

Figure 5, for instance, gives the speed curve of a 1,000 ton (984 English ton) goods train, hauled by a locomotive having 42 tons (41·3 English tons) of adhesive weight (total weight of locomotive and tender, 70 tons [69 English tons]) up a uniform gradient of 3·1 per mil.

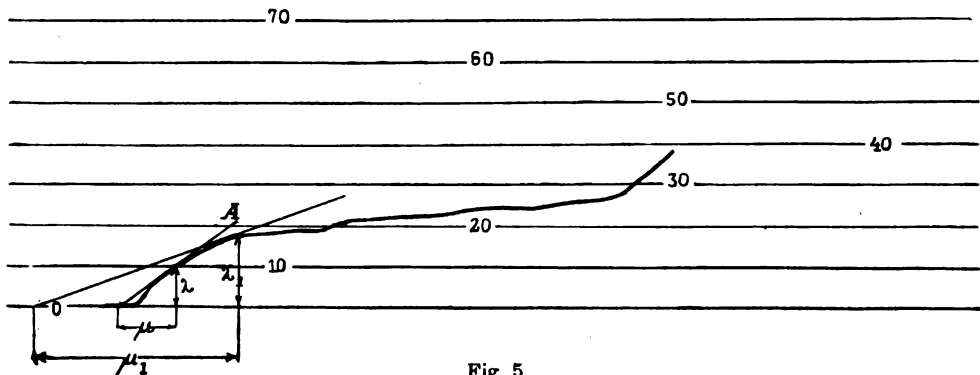


Fig. 5.

At the speed of 10 kilometres (6·2 miles) per hour, the figure gives for the tangent :

$$\frac{\lambda}{\mu} = \frac{10 \text{ (kilometres per hour)}}{2 \text{ (minutes)}} = 5$$

Consequently, according to equation (2) :

$$\frac{V_2 - V_1}{216} = \frac{5}{216} = \frac{E - R}{M}$$

whence  $R = \left(2.4 + \frac{10^2}{1,060 + 80} + 3.1\right) 1,070 = 5,981 \text{ kilograms (13,186 lb.)}$ ,

and  $M = \frac{1,070,000}{9.81} = 109,072$ .

Consequently  $\frac{5}{216} = \frac{E - 5,981}{109,072}$

whence  $E = 8,506 \text{ kilograms (18,753 lb.)}$ .

And as the adhesive weight of this locomotive is 42,000 kilograms (92,600 lb.), the coefficient of adhesion will be

$$\frac{8,506}{42,000} = \frac{1}{5} \text{ approximately.}$$

Similarly, in the case of point A, the speed being 17 kilometres (10·6 miles) per hour, we have :

$$\frac{\lambda_1}{\mu_1} = \frac{17 \text{ (kilometres per hour)}}{6.5 \text{ (minutes)}} = 2.61,$$

and equation (2) gives :  $\frac{V_2 - V_1}{216} = \frac{2.61}{216} = \frac{E - R}{M}$

whence  $R = \left(2.4 + \frac{17^2}{1,060 + 136} + 3.1\right) 1,070 = 6,144 \text{ kilograms (13,545 lb.)}$ ,

and, as in the former case,  $M = 109,072$ ;

consequently  $\frac{2.61}{216} = \frac{E - 6,144}{109,072}$

whence  $E = 7,462 \text{ kilograms (16,451 lb.)}$

and  $\frac{7,462}{42,000} = \frac{1}{5.6}$

Figure 6 shows the starting curve, as recorded by Hausshälter speed gauge, of a locomotive

having an adhesive weight of 29 tons (28·5 English tons), weighing together with its tender 100 tons (98·4 English tons), and hauling a 265 ton (261 English ton) train up a gradient of 6·7 per mil.

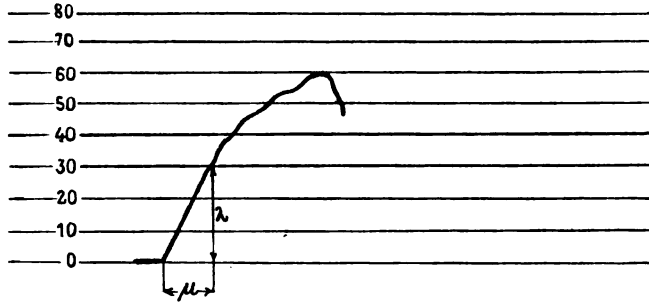


Fig. 6.

The curve is a straight line from 0 to 30 kilometres (0 to 18·6 miles) per hour; consequently, within these speeds the quotient  $\frac{\lambda}{\mu} = \frac{30 \text{ (kilometres per hour)}}{1·55 \text{ (minutes)}} = 19·3$  is constant.

$$M = \frac{98,500 + 265,000}{9·81} = 37,054.$$

When  $V = 30$  kilometres (18·6 miles) per hour,  $R = 3,558$  kilograms (7,844 lb.); consequently, according to equation (2)

$$\frac{19·3}{216} = \frac{E - 3,558}{37,054}$$

whence

$$E = 6,869 \text{ kilograms (15,144 lb.)}.$$

As the adhesive weight is 29,000 kilograms (63,934 lb.), the coefficient of adhesion is in this case :

$$\frac{6,869}{29,000} = \frac{1}{4·3}$$

Thus this coefficient is generally, as the examples given show, approximately  $\frac{1}{5} = 0·20$ ; and this may be assumed, under normal conditions of weather, as the mean value of the coefficient of friction between wheel and rail. We have here only taken as instances cases in which it could be assumed that the total adhesion of the locomotive was utilized for the acceleration.

## SUPERHEATED STEAM ON THE CANADIAN PACIFIC RAILWAY.

(Railroad Gazette.)

At the April meeting of the New York Railroad Club, Mr. H. H. Vaughan, superintendent of motive power of the Canadian Pacific Railway, read the paper of the evening. From this it appears, that during the past year a number of locomotives have been equipped with superheaters in addition to those in use at that time, all of which are of new construction. The types of superheaters used are the Schmidt fire tube, a modification of the Schenectady, which may be called the Schenectady B, and one designed by Mr. A. W. Horsey, mechanical engineer of the Canadian Pacific, and the writer which will be called the "C. P. R." The complete list of engines so equipped follows, those marked X being on order and not yet delivered.

TYPE OF SUPERHEATER.	Class of engine.	No. equipped.	Weight of engine.	Size of cylinders, inches.	Size of drivers.	Type of engine.
Schmidt . . . . .	700	10	190,000	21 × 28	63 inches.	10-wheel simple.
Schenectady B. . . . .	710	55	190,000	21 × 28	63 —	10-wheel simple.
C. P. R. . . . .	740	30	190,000	21 × 28	63 —	10-wheel simple.
C. P. R. . . . .	820	1	164,000	20 × 26	69 —	10-wheel simple.
C. P. R. . . . .	780	5	190,000	21 × 28	63 —	Do., W. F.
C. P. R. . . . .	1,150	3	215,000	21 × 28	69 —	Pacific.
X C. P. R. . . . .	7,000	15	190,000	21 × 28	63 —	10-wheel simple.
X C. P. R. . . . .	1,100	3	215,000	21 × 28	75 —	Pacific.
X C. P. R. . . . .	1,640	20	185,000	21 × 28	57 —	Consolidation simple.

This makes a total of 186 engines built or being built of the superheater type.

In the case of the Schmidt fire-tube superheater, the only alteration made in the "Schmidt"

design has been the substitution of separate bolting for each flange connecting the superheater pipes to the header, in place of using clips as in the original design. This has entirely overcome the trouble from leakage previously experienced, and while a small change, is a considerable improvement.

The "Schenectady" superheater used on the 1621 class employed the "Field" tube type of superheater pipe in which steam is led from the saturated steam header through the small tube to the rear end of  $1\frac{3}{4}$ -inch tube attached to the superheated steam header. The fire-tubes are  $3\frac{1}{2}$  inches in diameter, and each contains one  $1\frac{3}{4}$  inch superheater pipe. In the "Schenectady B" type of superheater, with which the 710 class engines are equipped, the well known design of "Schenectady" header is retained, but the superheater pipe and fire-tube arrangement is the same as in the "Schmidt" and C. P. R. design, namely, 22 fire-tubes 5 inches in diameter, each containing four  $1\frac{1}{8}$ -inch superheater pipes of which the back ends are connected in pairs by return bends while the front ends are connected in pairs to the saturated and superheated steam headers respectively.

The arrangement of the front end and the superheater tubes of the "C. P. R." superheater is shown in the illustrations of the Club proceedings. Steam from the dry pipe enters the top or saturated steam header, as shown in detail, and flows through the fingers of the header into  $1\frac{1}{4}$  inch solid drawn weldless steel tubes, inside diameter  $1\frac{13}{16}$  inch. These tubes are upset at one end and are forged and bent by a bolt header and bending machine to the shape shown in the proceedings. They are connected by bronze union nuts to special cast-steel fittings which screw into the header; a  $\frac{1}{16}$  inch copper wire gasket being used in the union nut. These small tubes extend into large 5-inch superheater fire-tubes to within about 30 inches of the back tube sheet, where they connect with the heavy cast-steel return bends. The steam returns from the return bend through  $1\frac{1}{4}$ -inch tubes, which connect through union nuts and special cast-steel fittings, similar to those mentioned above, with the fingers of the bottom-header. The steam pipes which connect this header with the cylinder casting, are necessarily very short; however, there has been no difficulty in making the joints tight. Each large superheater fire-tube contains two of the small tubes from the top header and the corresponding return tubes to the low header. The return bend has lugs cast on it, which spaces it properly from the sides of the large tube and the other set of small tubes so that there is a uniform circulation space about the small tubes. The caststeel return bend is made especially heavy at that part which comes in contact with the smoke and gases from the fire-box.

It will be seen that the "Schmidt," "Schenectady" and "C. P. R." superheaters now being applied on the Canadian Pacific, are identical in every respect with the exception of the arrangement of the headers and the connection to them to the superheater pipes. The primary object sought in the design of the "C. P. R." type, were the separation of the joints from the heater pipes to the headers, the location of these joints in a position where they could be conveniently inspected and an arrangement of the superheater pipes that would permit any individual element being removed or applied without disturbing the others. These objects appeared desirable after the experience on earlier engines, and it is evident they have been very satisfactorily obtained. The first is also satisfactorily met in the "Schmidt", by the separate bolting of the superheater pipe flangers to the header, and its need did not develop, to any great extent, in the earlier engines with the "Schenectady," although later experience would suggest its necessity, as more or less trouble is developing with the joints between the superheater pipe and main headers.

Both the second and third requirements are also partially met by the "Schmidt," but not as

thoroughly as in the "C. P. R." design, and in both respects, the "Schenectady" is deficient. It must not be understood that either of these types give especial trouble in service or are difficult to maintain; in fact, the reverse is the case, but the points mentioned are conveniences and advantages which are believed to have been obtained by the modification illustrated and their value will be appreciated from the roundhouse point of view.

The most important question in connection with superheaters, is naturally that of the coal economy obtained, and this is not easily determined, as all who have followed the effect of different improvements or proportions of locomotives will appreciate. Tests are open to the objection that they do not represent general service conditions and coal records, on account of their inaccuracy and lack of definite results. Tests on superheaters present, however, an additional difficulty over those directed to ascertain the relative economy of simple versus compound engines, or of wide versus narrow fire-boxes, where the efficiency of either the boiler or engines alone is involved, in that they must necessarily include the efficiency of the machine as a whole. The determination of the water consumption per unit of work is not sufficient, as it is quite possible for any advantage shown in this respect to be neutralized by less efficient boiler performance. Even with equal boiler efficiency, the additional heat in the superheated steam would represent a reduction in the water evaporated of one-twentieth of 1 per cent for each degree of superheat, or 5 per cent for 100° and 10 per cent for 200° superheat. In other words, if an engine with 100° superheat showed a saving in water consumption of 5 per cent, in comparison with an ordinary engine, and the boiler were equally efficient, there would be a saving in coal, and there must in addition also be some loss in boiler efficiency on account of the necessarily higher temperature of at least a portion of the smoke-box with any design of superheater.

It is, therefore, necessary in comparing superheaters with other engines to measure the coal consumption per unit of work. To do this, a rather extensive series of tests are required to average the influence of the efficiency of the firing with a dynamometer car to measure the work done, and owing to the latter not having been available during the past year it has been impossible to undertake them. During the past winter, a car has been constructed which will enable some experiments to be made, but at present the only figures available are those showing the tons hauled and coal consumed on the various sections of the road, and as these after all are the final arbiters of economical working, they afford so far as they are susceptible of proper comparison, the most satisfactory evidence that can be obtained. Such figures are not of great value when applied to individual engines, but when obtained from a number of engines, without specially selected crews, working together in regular service, they must certainly be regarded as reliable.

The two general classes of superheaters, consolidations and ten-wheel freight engines can only, on the Canadian Pacific, be compared with compound engines, as there are no simple freight engines in use on that road at all similar in size or design. Compounding has during the past few years become firmly established for freight service, and on account of the high cost of coal there would be no question as to its continuance had not the use of superheaters been introduced. Of compound engines there are, however, two classes which afford excellent comparisons; the 1,200 class consolidation, of which there are forty-one in use, and the 1,300 class ten-wheelers, of which there are thirty-seven. Both these classes are modern "Schenectady" compound engines, and although the 1,200 class is rather lighter than the 1,600, it has the same grate area and is a good engine for comparative purposes, while the 1,300 class is practically identical with the 700 class, with the exception of the change from compound to simple superheaters.

The dimensions of the various classes are given in the following table.

	CLASS				
	1,200.	1,300.	1,000.	1,621.	700, 710 and 740.
Boiler pressure, lb. . . . .	200	200	200	200	200
Fire-box, width, inside, inches . . .	65 <sup>5</sup> / <sub>8</sub>	70 <sup>1</sup> / <sub>4</sub>	65 <sup>1</sup> / <sub>4</sub>	65 <sup>1</sup> / <sub>4</sub>	69 <sup>7</sup> / <sub>8</sub>
— length, inside, inches . . .	96	102 <sup>1</sup> / <sub>8</sub>	96 <sup>5</sup> / <sub>8</sub>	102 <sup>1</sup> / <sub>8</sub>	...
Number of ordinary tubes . . . . .	281	378	244	255	244
Diameter of ordinary tubes . . . . .	2-inch.	2-inch.	2-inch.	2-inch.	2-inch.
Number of special tubes . . . . .	...	...	22	55	22
Diameter of special tubes . . . . .	...	...	5-inch.	3-inch.	5-inch.
Length of tubes . . . . .	14 ft. 2 in.	14 ft. 6 <sup>13</sup> / <sub>16</sub> in.	14 ft. 1 <sup>5</sup> / <sub>8</sub> in.	14 ft. 2 <sup>5</sup> / <sub>8</sub> in.	14 ft. 2 <sup>7</sup> / <sub>8</sub> in.
Number of superheater pipes . . . . .	...	...	88	55	88
Diameter superheater pipes . . . . .	...	...	1 <sup>1</sup> / <sub>4</sub> -inch.	1 <sup>3</sup> / <sub>4</sub> -inch.	1 <sup>1</sup> / <sub>4</sub> -inch.
Heating surface tubes, square feet . .	2,064	2,885	2,216	2,705	2,233
— — fire-box, square feet . . .	134	180	165	165	180
— — total, square feet . . .	2,218	3,065	2,381	2,870	2,413
Superheating surface. . . . .	...	...	375	340	378
Grate area, square feet . . . . .	43.6	50.0	43.6	43.6	50
Cylinders, inches . . . . .	22 × 35	22 × 35	21 × 28	21 × 28	21 × 28
Driving wheels, inches . . . . .	57	63	57	57	63
Total weight of engine, lb. . . . .	159,500	190,000	186,200	186,200	190,000
Weight on drivers, lb. . . . .	140,500	142,000	163,700	163,700	141,000
— of tender . . . . .	114,000	122,000	121,500	121,500	122,700
Water, imperial gallons . . . . .	5,000	5,000	5,300	5,000	5,000
Coal, tons . . . . .	10	10	10	10	10

In comparing road coal records, a good many difficulties are met with, some of which are usual on all roads, while others apply particularly to the Canadian Pacific Railway. The easiest figures to arrive at, those based on general averages, are not by any means reliable, and considerable study is necessary to ascertain the actual result. The consumption per 1,000 equivalent gross ton-miles, or as it may preferably be called per unit miles, varies considerably on different sections on account of the difference in profile, the consumption on the same section varies with the weather conditions, increasing from 25 to 50 per cent in winter over that required in summer; and also varies under the same weather conditions with the proportion between east and west-bound traffic. Engines are on account of the peculiar traffic conditions moved from one section to another more than is usual on most roads. Most engines have assigned crews, and in consequence, those engines doing the greatest amount of work on any section, as a rule give better relative results than those making fewer trips, as the latter are extra crewed and the men

are not so interested with the results. Taking these points into consideration, it will be found that the records of the summer work afford the most reliable results. According to these, and using the 1,200 compound consolidation as a basis, it has been found that the saving effected by the 1,600 class with 375 square feet of superheating surface, varied from 15 to 24 per cent, according to the division on which the engine was run and the amount of work done. On one division, between White River and Schneiber, the consumption on the engine with the superheater was 1 per cent more than on the compound. The other two classes, namely, the 1,300 class, which was a ten-wheeled compound, and the 1,621 class, a consolidation simple, gave results between the other two.

Assuming these comparisons to be accurate, the superheater locomotive has evidently shown itself to be rather more economical than the compound with the amount of superheat obtained, on the "Schmidt" and "Schenectady B" design, and from the good results obtained from the C. P. R. engines there is every reason to believe that still further economies will be reached. The results from these engines were entirely unexpected, as the design was developed from a mechanical standpoint entirely, and they are not by any means easy to explain, except that they must be caused by the steam being heated to a higher temperature than in the "Schmidt" or "Schenectady" engines. Since this was not discovered until December, it has been impossible to carry out proper temperature tests, on both types, but one made on one of the 740 class engines would indicate a higher superheat of 40°. In view of the superheating surface being identical, this can only be explained by the peculiar arrangement of the headers, which prevents any abstraction of heat from the steam, after it has been superheated, by the entering steam, by the tendency to a more equal flow of the steam through the various superheater pipes in passing from one header to another. In support of the first reason, the poor results obtained from the "Schenectady" A type are of interest. With 340 square feet of superheating surface against 375 in the "Schmidt" engine, the superheat was only about 20° as against 100°. This would show that any reduction in the temperature of the superheated steam by transferring its heat to the entering saturated steam is not as might be expected compensated for, and that the degree of superheat finally obtained may be seriously diminished by such action. The reason for this is not very clear, but a key to it may be found in the following data :

- a) Fire-box temperature, 2,000°; smoke-box temperature, 800°; flue, 16 feet long (at point I. from fire-box) = 2,000 — 200 nl.
- b) Radiation from superheater tubes equal to that from blackened copper in vacuo = 0.0854 B. t. u per minute, per square foot, per degree Fahrenheit.
- c) Boiler with 88 superheater pipes 1 1/4 inch O. D. 12 feet long using 20,000 lb. steam per hour with 150° superheat without abstraction of heat after superheating.
- d) Specific heat of superheated steam 0.6.

From the diagram worked by the author, it will be seen that there is a loss of 50° by the transfer of heat, on account of the increased radiation from the superheater pipes to the boiler and the decreased transmission of heat from the flue gases to the superheater tubes.

The results obtained from engine 820 in passenger service, have been very encouraging as have also those from the Pacific type. A graphic record of a test made on No. 820 shows that the superheat obtained varies from 160° to 200° at the steam chest. This engine has been in service since last June on the Lake Superior division between Chalk River and North Bay, and the results

for five months, June to October inclusive, compared with those obtained from two other identical engines on the same section were as follows :

—	Tons consumed.	Lb. coal per gross ton-mile.	Relative consumption.
Engine No. 823 . . . . .	763	160·0	111·5
— No. 820 . . . . .	734	143·5	100·0
— No. 838 . . . . .	913	199·0	138·5

There is a difference in the runs in which these engines are employed, all making three stops, but engine 820 having 11 flag stops against two for the other engines, which would, of course, increase the relative consumption of 820, so that while unsatisfactory on account of these figures referring to one engine, there is still but little doubt that the superheater is very satisfactory and economical in passenger service, and its relative economy does not decrease with increase of speed as is the case with compounds. The repair question is so far unimportant and nothing has developed to show that superheater engines will exceed appreciably simple engines when expenses that are fairly due to experimental construction are excluded. Lubrication on a superheater is identical with that in a simple, with the exception of the additional cylinder connection required, and what is wanted is simply to deliver the oil to the required spot.

In conclusion, the writer sees no reason to change the opinion previously arrived at, that the superheater steam locomotive attains equal or greater economy than the compound without any of its disadvantages, and would now add to this by stating that the employment of higher temperatures with the still further economy is relatively practical, and to that on engines now under construction the proportions of superheating surface will be increased to attain this result. It is especially advantageous in passenger service and so far no counter-balancing disadvantages have been developed which are worth considering. Whether this is due to special conditions on the Canadian Pacific Railway or not superheating is certainly successful on this road, and there is so far no inclination to discontinue it.

#### DISCUSSION.

It was prominently set forth early in the discussion that the simple locomotive is especially adapted to the use of superheated steam. It has been found that where the engine is complicated by multiple cylinders, condensers or other auxiliary apparatus, the saving effected by the use of superheated steam is not as great as in the case of what may be called primitive engines. In fact, while the saving may well drop to 5 per cent in the former it may rise to 30 per cent in the latter class.

Yet, while the engine itself is well adapted to the use of superheated steam, it is difficult to design an apparatus to do the work on account of the form of boiler that is in universal use. The difficulties that may arise due to the elimination of a certain amount of the heating surface is of no account and may be disregarded. It is the space and form that gives the trouble.

In reality, the steam generator should be a three-stage affair and should consist of the boiler,

the superheater and the economizer. The latter utilizes the waste gases at their lowest temperature to heat the water at its lowest. The superheater uses the hot furnace gases as they escape to add heat to the steam, and it is thus protected from the intense heat of the fire-box. The boiler is constructed to withstand the high temperature of the gases immediately after and during the process of combustion and thus convert the water into steam.

A superheater has the peculiarity that it is always economical, which may not be the case with other auxiliary apparatus; the condenser, for example. There are cases where a condenser not only may effect no saving, but may even be the cause of an increased water consumption, but this is never the case with a superheater.

Another advantage of introducing the superheater, lies in the fact that the pressure can be reduced on old boilers and the same amount of work obtained as before. In fact, where the superheater has been introduced, there is a tendency to lower the boiler pressure. On some new engines for the Canadian Pacific, the pressure will be 175 lb. instead of 200 lb. on similar engines. The cylinders will be slightly larger, and it is expected that the superheated steam will do as much work and more economically at this lower pressure than the higher pressure on the other engines. Should this expectation not be realized, the cylinders will be bushed and the pressure raised to 200 lb., as the boilers will be strong enough to carry it.

An important matter to be borne in mind in the designing of a superheater, is the means employed for the regulation of the gases, for it is upon this that the efficiency of the apparatus largely depends. Another point is the desirability of securing a uniform flow of steam through all parts of the superheater, and this, it is thought, is accomplished to a marked degree in the C. P. R. design, a fact that accounts to a great extent for its very satisfactory efficiency.

There was some criticism of the results given in the main paper, in that the coal records were probably inaccurate, as they are upon most roads, and to this was added a criticism of the heating surfaces given, in that the flat areas of the receivers were omitted, which increased that of the C. P. R. type very materially, and did not greatly affect the others. The speaker, however, rather weakened his criticism of Mr. Vaughan's percentages in that he ended by giving the savings that had been effected on the Belgian roads. These engines using the superheater had saved 30 per cent in water, 24 per cent in coal, and hauled an increase of 6 per cent in tonnage as compared with a four-cylinder compound of the same calculated tractive power. In Sweden, again, a simple engine with a superheater had saved 26.7 per cent in coal as compared with another simple engine of the same design.

These results have been obtained only by a persistent trial, for five years ago the prospects of success with the superheater were most discouraging in Germany.

As for the amount of superheat, it was considered useless to raise the temperature beyond a point where cylinder condensation is prevented, and 200° Fahr. will do this. With such an amount of superheat the pressure can be reduced from 30 to 50 lb. This is a matter that should receive most careful attention, since there is no doubt that in the struggle for savings with the compound engine, the pressures have been carried too high, and the result has been excessive boiler repairs.

While there is some doubt still as to the effect of compounding on engine repairs, there seems to be none that the introduction of a superheater does cut down boiler repairs, and so it was urged that this alone was reason enough for proceeding rapidly with the introduction of superheaters on locomotives, for they certainly add to the capacity.

It was urged that the value of the superheater depends largely upon the cost of coal, and that where this was expensive, the apparatus was good to use, but where fuel was very cheap it would

not be worth while to make the application, The reply to this was that unless the price of coal was less than a dollar a ton, the saving of 15 per cent that could well be depended upon fully justified the extra expense.

One of the principle points to be considered in the superheater is its value to the fireman, who appreciates it most if it relieves him when he is called upon to work the hardest. It was, therefore, claimed by one speaker that inasmuch as fully 20 per cent of the fuel used was burned when the engine was standing and the superheater of no use, that the real efficiency of the latter would not amount to more than 5 per cent.

On the Chicago, Rock Island & Pacific, there are six locomotives with the Cole superheater, but the results obtained have not been altogether satisfactory. The Illinois coal that has been used contains quite an amount of iron, and this forms hard pieces on the ends of the tubes that clogs them and is very difficult to remove. This accumulation takes place so rapidly that it sometimes fills them on a single trip. For this reason, the trial has not been altogether satisfactory, though, in spite of the trouble thus experienced, very fine results have been obtained, and with a coal that leaves no deposits the other troubles that have arisen can probably be cleared away in time.

In lubrication a number of experiments have been tried with a positive feed, the results of which have not been very satisfactory. This was partly due to the mechanism used and partly to a misunderstanding of what was required. As a consequence of the experience thus obtained, there has been a reversion to the sight feed lubricator and two connections, one to the cylinder and one to the steam chest, for it is essential that the oil should be delivered to the point where it is to be used. It is now proposed to use a five-section lubricator.

The figure of 0.60 for the specific heat of the steam was criticized as being higher than the generally accepted 0.48. The reason given for this choice was that the specific heat varies with the temperature rising from 0.48 to 0.75, and that 0.60 is a fair average between the two. When the cut-off is long, the amount of superheat is low, and *vice versa*.

Finally, in the consideration of the various types of superheaters, it should be remembered that Mr. Schmidt is not the pioneer in the introduction of the superheater, but of high superheat, an end that is not needed, as already shown. Neither is it desirable or necessary to resort to a special construction of engine, as advocated by Mr. Garbe. This engineer suggests the use of cylinders of such dimensions that a uniform cut-off at one-third stroke can be obtained, and that the speed be regulated by the throttle. It is hardly necessary to call attention to the inadvisability of imposing such a condition on American locomotives. The over-cylindering would be such that they would spin themselves to pieces. It is far better to disregard any such suggestions as this and so design the engines that the proportions of cylinders and weights on the driving wheels are such that they will always keep their feet.

---

# PROCEEDINGS

OF THE  
SEVENTH SESSION

WASHINGTON : MAY, 1905

---

2<sup>nd</sup> SECTION. — LOCOMOTIVES AND ROLLING STOCK.

---

[ 621 .33 ]

QUESTION VIII.

---

## ELECTRIC TRACTION

(2<sup>nd</sup> AND 5<sup>th</sup> SECTIONS JOINTLY.)

---

*Progress made in electric traction on important lines of railways.*

*Continuous current, alternating current, polyphase current.*

*Experiments made with high tension currents.*

### *Reporters :*

*America.* — Mr. W. D. YOUNG, electrical engineer, Baltimore & Ohio Railroad.

*France.* — Mr. F. PAUL-DUBOIS, ingénieur des ponts et chaussées, ingénieur du service central du matériel et de la traction du chemin de fer d'Orléans.

*Great Britain and Belgium.* — Mr. Ernest GERARD, inspecteur général, chef du cabinet du ministre des chemins de fer de Belgique.

*Other countries.* — Mr. Victor TREMONTANI, ingénieur, inspecteur principal, chef de la section électrique des chemins de fer italiens de la Méditerranée.

---

## QUESTION VIII.

---

## CONTENTS

---

	Pages.
Sectional discussion . . . . .	1375
Report of the 2 <sup>nd</sup> and 3 <sup>th</sup> sections meeting jointly . . . . .	1410
Discussion at the general meeting. . . . .	1410
Conclusions . . . . .	1418
Appendix I : Corrigenda to the report No. 2, by Ernest GERARD . . . . .	1420
— II : Letter from C. Rota and E. Grismayer on Mr. Victor Tremontani's report No. 4. . . . .	1421
— III : Remarks on Mr. Victor Tremontani's report No. 4, by C. DE GULACSY. . . . .	1422

### PRELIMINARY DOCUMENTS.

Report No. 1 (France), by F. PAUL-DUBOIS. (See the *Bulletin* of March 1905, p. 1253.)

Report No. 2 (Great Britain and Belgium), by Ernest GERARD. (See the *Bulletin* of February, 1905, 2<sup>nd</sup> part, p. 939.)

Report No. 3 (America), by W. D. YOUNG. (See the *Bulletin* of February, 1905, 1<sup>st</sup> part, p. 629.)

Report No. 4 (other countries), by Victor TREMONTANI. (See the *Bulletin* of April 1905, p. 1365.)

Vide also the separate issues (in red cover) No. 29, 36, 40 and 42.

---

# SECTIONAL DISCUSSION

---

(2<sup>nd</sup> AND 5<sup>th</sup> SECTIONS JOINTLY.)

---

Meeting held on May 11, 1905 (morning).

---

Mr. ED. SAUVAGE, PRESIDENT OF THE 2<sup>nd</sup> SECTION, IN THE CHAIR.

**The President.** (In French.) — To-day we have to consider the subject of electric traction upon which four reports have been written. I beg to call upon Mr. Paul-Dubois.

**Mr. Paul-Dubois, reporter for France.** (In French.) :

The applications of electric traction on railways, made up to the present in France, are based, like the greater number of those made in other countries, on the use of *continuous current motors*.

This system of traction is directly derived from the system used everywhere to-day on tramways, only more powerful motors are used. The controller has been adapted to suit the powerful currents required for railway work. The ingenious method of controlling any desired number of motors from a distance, by interconnecting the individual controllers, has made it possible to increase the number of driving wheels in a train to any desired extent.

It has also been necessary to increase the cross-section of the conductors supplying the current and this has led, in most cases, to the replacing of the overhead conductor by the third rail.

But the system of electric traction by continuous current has one grave defect : it is not suited to the use of high voltage currents.

Up to the present, hardly anything beyond 700 volts has been used in practice for operating continuous current motors for traction, and it does not seem advisable to exceed this voltage materially, on account of the difficulties of insulation and commutation.

The transmission of energy at such a moderate voltage, results in a prohibitive cost for the mains as soon as the amount of energy or the distance over which it has to be transmitted, become at all large.

From this point of view, there is a radical difference between tramways and railways. In the former case, not more than 20 or 30 horse-power are required at any given point, which is seldom more than 20 kilometres (12·4 miles) distant, whereas in the latter, hundreds of horse-power have to be transmitted over tens or hundreds of kilometres.

The distribution limit for continuous current is then soon reached, and it becomes necessary

to multiply the points from which current is taken. To do this, without at the same time multiplying the generating stations, the usual course is to resort to *transformer sub-stations* in such a case, which derive their current from a main station as high tension current, and these feed the various sections of the line with continuous current.

This system has been applied more particularly on the line from Les Invalides to Versailles, on the line from the Quai d'Orsay to Juvisy and on the Paris Metropolitan and it is about to be applied on the extension of the Fayet-Chamonix line to the Swiss frontier, to mention only applications made in France.

This arrangement, which at present is in general favour, makes it possible to extend very largely the field of action of continuous currents.

This advantage, however, is attended with considerable expenditure, both in construction and in working.

The use of storage-batteries as regulators allows the irregularity of the traffic to be equalised to a certain extent; but this, as we know, is a costly expedient, although accumulators, in the case of railway working, form an element of safety which is not to be disdained in certain cases.

Thus it would evidently be a great advantage, from the economic point of view, to increase the voltage at which the energy is transmitted, and at the same time reduce the number of connecting links between the central station and the motors on the trains.

Numerous attempts in this direction have been made.

We may mention more specially the "three wire" system, applied in France on the Grenoble-Chapareillan tramway, and on a section of the Saint-Georges-de-Commiers-La Mure railway.

Some engineers have thought to find the solution of the problem of electric traction in the series system of distribution with constant current, which has had several interesting applications in stationary installations. But the extreme mechanical complexity of the systems proposed, with their multiplicity of commutators and switches, more ingenious than practical, serves to explain why this system of distribution has not become extended. We may add that two or even three lines of wires would be required, that any accidental interruption in the circuit would paralyse the whole system and finally, that there would be an entire want of elasticity in its working.

Another solution consists in having a high voltage alternating current applied to the train and *transforming it into continuous current on the locomotive itself*. In this way, the facility of distribution inherent to alternating currents, is combined with the safety and elasticity of working which are characteristic of continuous current motors.

Lastly, other methods involve the use of the *alternating current* exclusively.

Up till lately, the only alternating current motors capable of being utilized for traction were *asynchronous polyphase motors*, which have been used in Europe, mainly in Italy and Switzerland. They are of great interest, but they possess the disadvantage of requiring at least two conductors from which current is taken.

*Monophase alternating current motors*, long forgotten in this connection, have been improved recently in view of being used for haulage purpose in various directions simultaneously; thus in America by Mr. Lamme, in Italy by Mr. Finzi, in Germany by Messrs. Winter and Eichberg, in France by Mr. Latour. The motors proposed by these different inventors are all "collector" motors either of the series type with laminated poles, or of the repulsion type or are a combination of both these types.

With this system of traction, only one conductor is required, if the track rails are used for the return. By distributing the current at a sufficiently high voltage, a marked saving can be effected in the cost of the electric equipment of lines, so high with the continuous current system.

Moreover, the speed of the monophasic commutator motor can be regulated without any loss of energy in resistances; for instance, by varying the voltage at the terminals of the motor by means of a static transformer having a variable transformation ratio. Apart from the elasticity of the working which results, the corresponding reduction in the fluctuations of the load forms a very appreciable advantage in the case of railway service. But it would be too soon to assert that the new motor will be equal to rendering all the services that are now managed by the continuous current motor; a fair number of side problems still require to be solved, especially that of taking the overhead current; it is therefore necessary to wait for further results before any definitive conclusions as to this system can be reached.

In summarizing the situation, we may say that the use of electric traction on railways is already practicable in all cases where its use would be considered advisable from the economic point of view.

This does not mean that all the technical difficulties are by now completely overcome, but only that their solution would not involve any obstacle too great for the present resources of industry; existing processes and appliances have shown their capabilities in applications sufficiently different to make it certain that the elements necessary for the solution of any practical problem are to be found in them.

It is certainly desirable to improve them still further, and the principal object ought to be the reduction of the cost of installation and of working.

It may indeed be said that under present conditions, apart from the cases where electricity must necessarily be used (*e. g.* for operating lines which are chiefly underground), electric traction can only find economical application where there are special conditions.

Without here wishing to enter into the question of first cost, which is too complicated and about which we have at present too few data to make it possible to treat it with any accuracy, it is, nevertheless, interesting to consider what are the present conditions favourable to the use of electric traction.

As this motive power is especially advantageous for comparatively light trains following one another at short and regular intervals, it is obvious *a priori* that short distance passenger traffic is that which offers the most favourable field. Moreover, it is almost exclusively to this class that the applications already made on railways belong. Electric traction of goods trains exists only as an exception justified by peculiar local conditions. It may be said in a general way that in services of this kind, the economy of the system increases with the reduction in the weight of the trains and with the increase in their number.

Leaving out of consideration metropolitan railways, which form a special class for which electric traction is now a necessity, then, from the point of view which we have been considering, the suburban lines of some large towns may offer conditions favourable to the use of electricity.

The latter moreover, in the case of services with many stops, has the great advantage that it makes it possible to increase the average speed materially, owing to the rapidity of starting electric motors. The absence of smoke, the better lighting of carriages and stations are other advantages, which although only of a secondary character, yet also contribute considerably to the general improvement of the service.

Similar conditions will be found to occur on sundry busy lines connecting large centres, not very far apart, in industrial districts, where the service must assume as nearly as possible the character of a tramway service.

On lines of this kind and even on certain secondary railways, the increased facilities of transport made possible by electric traction may lead to important increases in the traffic and in the receipts.

Another case where the adoption of electric traction is worthy of consideration is that of lines which are worked up to their full capacity.

For electric traction indeed makes it possible, under certain conditions, to increase the capacity for traffic, while avoiding more costly measures such as quadrupling the track or enlarging the terminal stations. This possibility is due, in the first place, to the greater speed of the trains, resulting from quicker starting and less loss of speed up gradients, and secondly to the reduced blocking up of the terminus stations owing to the smaller number of operations necessary to receive a train and then clear the siding for the next train.

Doing away with smoke and steam in long tunnels will of itself make it possible, in the case of some very important lines, to subdivide them into very short block-sections, thus enabling them to carry more traffic than with steam traction.

The great specific power of electric motors is specially in favour of their use on mountain railways, whether adhesion or rack railways. We know that an electric locomotive need not weigh more than 40 to 50 kilograms per horse-power (89 to 112 lb. per British horse-power) and the equipment of a motor car not weigh more than 20 to 25 kilograms per horse-power (45 to 56 lb. per British horse-power).

The relative lightness of electric vehicles also makes them suitable for obtaining very high speeds. The large amount of power which is necessary to run a train at from 150 to 200 kilometres (93 to 124 miles) per hour, can more easily be furnished by electric motors fed from outside, than by a steam locomotive, the weight of which increases rapidly with the speed to be attained; the recent experiments made in Germany have proved (if indeed it was necessary) the superiority of electricity from this point of view.

No doubt, before definite application, there are still numerous practical problems to be solved, in connection with the safety, the brakes, the signals, etc.

But the most serious obstacle to such a great increase in speed is the considerable expense which would be entailed.

On the whole, it seems to us that electric traction should at present be looked upon as a useful auxiliary to steam traction, capable of operating certain parts of railway traffic with advantage and economy. The principal cases in which its adoption may at present be feasible are: firstly on lines which are chiefly underground, then on metropolitan and on suburban lines, on inter-urban lines of limited length and with much traffic, on railways with steep gradients, and on lines which are worked up to their full capacity.

It is impossible to indicate in a general report in any more definite way the cases in which the system of working may lend itself to the application of electricity; it is essentially a question of degree, and each individual case requires special examination. In this examination, special consideration must be given to the cost of the electric equipment, the principal factors of which are, in the first place, the conditions of working, the number and weight of the trains, and secondly the conditions under which the line is built, its length, profile and plan; then the charges for interest and sinking fund of the capital outlay required must be compared with the economy which electric traction will give, as compared with steam traction.

If it is a question of a new line, the adoption of electric traction may, in certain cases, result in a lower cost of construction, whereas in the case of existing lines, the value of the rolling stock which will be rendered useless by the introduction of electricity, has to be taken into consideration and written off.

Among the conditions in favour of electric traction are naturally the proximity of easily utilizable water power or of other cheap sources of energy, such as coal pits and blast furnaces.

In comparing the cost of traction, we must allow in the case of electricity, in addition to the eventual economy realized in the production of energy for the reduction of dead weight resulting from the smaller weight of electric locomotives, the reduction in the cost of driving and of maintenance, as well as for the accessory economies capable of being effected in shunting operations at stations, in lighting the stations and trains, etc.

Finally, if so happens, the increased receipts which may result from the improved service have also to be taken into consideration.

In any case, the problem becomes in the end a financial and economic one.

**Mr. Van Loenen-Martinet, Dutch Railways.** (In French.) — Gentlemen, we have all read the splendidly clear reports that have been prepared on this subject; consequently everybody knows the main points, and it seems to me we shall be wasting an immense amount of time in listening to summaries of these papers. I think therefore we might ask the reporters to confine themselves to reading their conclusions. (*Agreed.*)

**Mr. Ernest Gerard, reporter for Great Britain and Belgium.** (In French.) — Personally I had intended to confine myself to reading the conclusions of my report after having first mapped out the subject, as I have done on the first page of my paper. I stated that among the applications of electricity of main-line railways, it was necessary to distinguish between two quite different methods in applying this improvement. One lies in altering entirely the method of traction over a given section on the lines of a railway system, by fitting up along the tracks something to convey current from a distance and so supply energy to rolling stock provided for making frequent journeys, so as to attain a class of working analogous to that of tramways. With the other method, we are content to use a few automotor carriages which carry their source of energy in the form of accumulators or some other means of generating electrical power internally, the object being to use instead of rather costly steam trains, on sections that are not very busy, lighter rolling stock hauled at less cost *per diem*, and that would cost when standing idle in the intervals between two trains nothing beyond the wages of the staff as working expenses.

It is to the first method that the English have applied the word “electrification” — a characteristic word that we shall adopt to signify an alteration which applies not only to the rolling stock, but embraces also the changes or additions to the track and the construction of important fixed plant for the generation and transmission of the current.

The second method, by which only the rolling stock is modified, may be regarded as a kind of automobilism.

This distinction explains the subdivision of my report and conclusions.

A preliminary question relating to this subdivision must first be attacked.

Some time the section will be asked to decide whether its enquiries should be confined to the questions of electric traction relating to the first method, in other words, whether it should exclude from discussion the subject of automobiles which has already been dealt with by another section and limit itself solely to question VIII.

My report describes then all that has been done in England in the matter of

substituting electric traction for steam traction on railways and you have been placed in a position to observe that in England the only system followed is the transmission of current through a third rail, modified on some lines by the addition of a fourth rail. It would perhaps be interesting to discuss in what cases a fourth rail appears obligatory.

I beg to draw the attention of the section especially to a portion of my report where some technical results are dealt with and above all those which concern safety. Many methods have been suggested to protect the staff from the risk of contact with the third rail. In England, the Board of Trade has issued reports which I mention in reference to various accidents of this kind; it has also issued some bye-laws which apply to underground railways especially; these I have reproduced at the end of my report.

We shall then have, in the first place, to consider what method of protection seems to combine the conditions of efficiency and economy and secondly at what points the third rail ought to be covered in.

I do not think I need stop to allude to the few financial data I have been able to collect, but I hope that Mr. Aspinall, who is here, will tell us some of the results of the very interesting experiments he has doubtless collected on the Liverpool and Southport line. My only further duty is to read the conclusions I have suggested at the end of my report.

*Electrification.* — In England, on the lines where electric working is now in operation, the electrification is attended with an increase in the number of trains and consequently in the facilities offered to passengers. The results obtained show that this is followed by an immediate increase in the number of passengers and in the receipts, with a material decrease in the cost per train-mile, with an increase in speed, a considerable increase in comfort, particularly in tunnels, and that this forms an attraction which has a serious influence on the number of passengers carried. The danger to people who have to move about in the neighbourhood of the third rail, and the dangers which result from short circuits, can easily be avoided.

*Automobile cars.* — In so far as it is a question of trains at rare intervals, on sections where there is no advantage in increasing the number of trains, automobile cars make it possible to realize some economy as compared with trains hauled by steam locomotives; electric automobile cars have the advantage that the speed can easily and readily be controlled with great simplicity and certainty from either end of the car without any necessity for turning the car round. Experience will show whether accumulators or dynamos driven by petrol motors give the better results.

Before commencing the discussion, perhaps it would be well to leave the way open for Mr. Young to submit his report too.

**The President.** (In French.) — Mr. Young will now kindly give us a summary of his report, in as few words as possible, so as to conform with the wish just expressed by the meeting.

**Mr. W. D. Young, reporter for America.** — In the conclusions which he has just read Mr. Gerard says : " The danger to people who have to move about in the neigh-

bourhood of the third rail, and the dangers which result from short circuits can easily be avoided. " It seemed to me, to that should be added " provided the right of way is properly protected. "

After this preliminary remark, I shall now read you a summary of my report.

In order to obtain the information desired, I have prepared a set of questions, 209 in number which were forwarded to 222 railroads, from which 171 replies were received, leaving 51 which did not respond. Of the 171 replies, eight were from steam roads that were using electricity and were in a position to furnish information. From these I have compiled the report.

The eight roads above referred to are :

The Baltimore & Ohio Railroad Company;  
Boston & Maine Railroad;  
Chicago, Burlington & Quincy Railroad;  
Hocking Valley Railroad;  
Long Island Railroad;  
New York, New Haven & Hartford Railroad;  
North Shore Railroad;  
Pennsylvania Railroad.

The questions and replies are as stated in the appendix I.

From the foregoing tabulated information taken in comparison with Mr. N. H. Heft's report read before the International Congress in 1900 <sup>(1)</sup>, the following interesting facts are observed : Firstly, that the larger roads that have interest themselves in the use and development of electrification, have increased in number from three to eight; secondly, the miles of track operated has correspondingly increased from 81.2 miles to about 172 miles; thirdly, there are special cases noted where the speed has increased from a maximum on the level of 40 miles to 48 miles per hour; fourthly, the load has not increased materially in the special case given, *viz.* : the Baltimore & Ohio, although there is a tendency towards increasing the train load, and to meet this condition, the railroad company has purchased larger and heavier locomotives since the report of 1900 was made.

The alternating current motor with its inherent advantages of high voltage distribution is eminently adapted to replace the steam locomotive on either high speed passenger or heavy freight haulage work; and as the compensated type of motor is perfectly adapted to operate on both A. C. and D. C. trolley, the alternating current motor must be considered a large factor in future suburban railway systems. The compensated motor is essentially a variable speed motor differing in this respect from the multiphase induction motor whose constant speed characteristics proved so serious a handicap to its successful adoption in railway work. The speed torque characteristic of the compensated motor, is very similar to that of the direct current series motor, while its commutating qualities and method of control prove equally satisfactory.

In conclusion, I wish to say that the profession at large have felt the keenest interest in the development of the alternating current motor. The importance has long been manifest, that if electrical railroad service is to make the rapid strides in the future that it has in the past, greater regard must be paid to the economy of distribution, which means ultimately higher

---

<sup>(1)</sup> Vide *Bulletin of the Railway Congress*, No. 5, May, 1900 (2<sup>nd</sup> part), p. 1453, and *Proceedings of the sixth session* (Paris, 1900), vol. 4, p. XIX-3.

working voltages and, if possible, the elimination of the present method of distribution to sub-stations. We are then confronted with the problem of perfecting an alternating current motor. The inherent defects of the polyphase motor in securing variable speeds and inability to make up time, practically condemns it for railway work in general; at least I believe this opinion is largely shared by American engineers.

There has, therefore, to be evolved a machine which could successfully work on long lines where long distance transmission is essential.

How successfully this motor will operate under the exacting conditions that are presented in hauling of freight on our present commercial lines, still remains a matter of speculation.

**Mr. Paul-Dubois.** (In French.) — In the absence of Mr. Tremontani, I shall now read you the conclusions of his report :

I. — General features :

a) Electric traction offers a number of advantages of a technical nature, in working and in economy, over the existing methods of steam traction and although — to judge by the limited number of practical trials made up to the present — the problem does not appear to have been solved completely and finally (except in certain special cases : metropolitan, suburban and mountain railways), the question of the application of this new and seductive method of traction to large railways is worthy of serious investigation, not only in the case of companies working metropolitan lines and those working the suburban traffic of some of the large provincial towns, but also of the others, and more particularly those which have to meet the fierce competition of electric tramways :

b) The application of electricity to the traction of railway trains is now a necessity and requires to be seriously investigated and applied, particularly in the case of countries — like Italy and Switzerland — where coal is dear and where, on the other hand, there are powerful natural sources of supply of energy.

II. — The electric supply system to be adopted :

a) The system of separate automotor vehicles with batteries of accumulators has not given good results, and until there is a new accumulator, of very light construction, with very large capacity and capable of being charged very quickly, there is no prospect of the application of this system to railway traction even for short distances and over easy lines ;

b) In the present state of science, it appears probable that electric traction on railways proper will only be possible practically by the use of current generated by stationary plant at central stations, transmitted to the locomotives by insulated conductors laid along the permanent way and utilized in the motors on the train. This is now rendered more easy by the advance which has been made in high tension generation, distribution and conversion, currents at 60,000 volts being now generated in several stations, enabling any amount of electric energy to be conveyed with certainty, ease and economy to sub-stations up to a distance of 400 kilometres (249 miles), so that it would now be possible to supply a line of railway 400 kilometres in length from a single generating station ;

c) The *continuous current system* has been thoroughly tried and its use in traction on railways has demonstrated its excellent qualities of large range of load (great acceleration) and elasticity ; it is to be preferred where it is a question of a railway with heavy passenger and goods traffic, and where a frequent and quick service is required ;

d) The *three-phase current system* is complicated, and has the disadvantage of loss of a considerable amount of energy in the resistances when starting ;

e) A great movement in favour of the *single phase system* has taken place during the last few years in Italy and in Germany, and is spreading little by little also in America. This last system is theoretically better than the preceding, and although the applications of the single phase motor to railway traction are but in their infancy, it may be definitely stated that in them will be found the solution of the problem for light railways, and for those lines which run into towns where this motor can also utilize the continuous current supply.

### III. — From the service point of view :

In the first place, it must be borne in mind that the ideal traffic for passengers is that obtained by a service similar to that on tramways but at high speed; that is to say, that the existing trains which start at intervals of several hours should be replaced by light trains running at short intervals. Now in order to obtain greater speed for the existing trains, the steam locomotive cannot be used, as it has nearly reached its limits of economy and power, and we must turn to the electric motor which can easily give the extreme speeds at present in demand for express trains. To obtain the frequent service desired by the public, steam trains cannot be multiplied without largely increasing the working expenses, whereas with electric traction, the increase in number of the trains entails but small additional expenditure.

With the adoption of electric traction on railways, a new service should be commenced with frequent fast trains of smaller size. The ideal with electric traction is the automotor vehicle itself forming the whole train.

The reporter is of opinion that the following conclusion may be drawn : that in the future trains of great length will no longer be run (except for long distances), and that numerous short trains will be run instead. This result will in a great measure depend on the advances made in electric technology ; but even now, the possibilities of electricity and of its mode of transmission are realized as affording several good solutions, none of which can be regarded as final, but all of which have their advantages according to the mode of application and to local conditions.

**The President.** (In French.) — Gentlemen, you have now heard the very brief summaries of the reports and the conclusions submitted for the approval of the section.

These reports are of such high importance and of such great length that the summaries to which we have listened, though reduced to a minimum, have taken rather a long time which however has not been wasted.

I now declare the discussion open upon all four reports.

**Mr. Schulz,** German Government. (In German and in English.) — Some experiments were made in Germany with high speed electric traction. The object of these experiments was to determine scientifically if high speed electric traction were possible and satisfactory on main railway lines. For this purpose, a special commission, called the Society for investigating fast travel on electric lines (*Studien Gesellschaft für die electrische Schnellbahnen*), was formed in Berlin in 1899.

In a great number of trial runs, speeds of 200 to 210 kilometres (124 to 130·5 miles) per hour were attained, which are much higher than those previously reached.

The experiments showed that the ordinary type of superstructure, properly

strengthened, would suffice for speeds of 200 kilometres (124 miles) per hour and more, and that, on the other hand, the general arrangement of express passenger cars is well adapted to great speeds, provided the wheel-base be sufficiently increased.

Because of the great amount of energy to be transmitted to the motors, it had been found convenient to use the three-phase current with a tension of 10,000 to 12,000 volts.

The current was transmitted by three copper wires of 100 square millimetres (0.155 square inch) sectional area each, placed one above the other in a vertical plane, on one side of the permanent way. The bowlike pole for taking the current was very light and provided with double acting springs which pressed the pole against the wires with a sufficient pressure to assure a good contact at the highest speed. The experiments have shown that it is thus possible to transmit a great amount of energy to an electric car going at a high speed. The arrangements used have, in fact, permitted the transmission of as many as 2,000 kilowatts to cars going at a speed of almost 60 metres (197 feet) per second, and this under unfavourable atmospheric conditions.

The experiments have also shown that three-phase motors were well adapted for high speed traction on main lines. The starting resistances, liquid or metallic, have worked well.

In all observations, special care was taken to determine the speed in an exact manner. The trial cars were furnished for this object with special apparatus of the Morse type.

The measurement of the total resistance to traction has given the following results : the resistance due to friction which is only 1.5 kilogram per ton (3.36 lb. per English ton) at a speed of 5 kilometres (3.1 miles) per hour increases gradually with the speed and becomes 3 kilograms (6.72 lb. per English ton) at a speed of 200 kilometres (124 miles) per hour.

The resistance due to the air increases much more rapidly with the speed; though practically *nil* at 5 kilometres (3.1 miles), it rises to 200 kilograms per square metre (41 lb. per square foot) of the automotor vehicle's front surface at a speed of 200 kilometres (124 miles). It is this resistance which really limits the speed which can be realized. The resistance of a trail car is much less than that of the first automotor car, because it is partially protected by the motor car. It is, therefore, more economical to make up the trains of several cars than to run single automotor cars at short intervals, though the latter system is more satisfactory from the public point of view.

With a slowing down of  $1\frac{1}{2}$  metre (4.92 feet) per second, which can be realized without danger to the passengers, trains running at a speed of 160 to 200 kilometres (100 to 124 miles) per hour can be stopped in a distance of 650 to 1,000 metres (710 to 1,094 yards), respectively.

At speeds higher than 120 kilometres (74.6 miles) per hour, the signals could not be seen during bad weather in sufficient time. This has been improved by means

of an electro-magnetic arrangement which places a red disk before the eyes of the motorman if the signal in front of him is at "danger".

More than three hundred trial runs were made without any accident.

This opens a great field to railroad engineers and electricians, and I express the wish that the operation of a high speed electric railroad may soon become an accomplished fact.

**Mr. J. A. F. Aspinall**, Lancashire & Yorkshire Railway, Great Britain. — The description which Mr. Gerard has given of the Liverpool & Southport Railway is so complete that I do not think I can add anything to it of a technical character, but I fancy I understood him to say that he considered that electric traction would result in economy of working. We did not enter into electric traction with any idea that we should get economy of working. We did not expect to save money; we expected to make money, — two very different things. We started to operate our line on the 22<sup>nd</sup> of March last year, and therefore, we have had practically twelve months' experience, and the results in the increase of traffic have been most satisfactory, but the results of operation have shown us that we were right in expecting that it would cost more money to work than it did when we used locomotives in the ordinary way. The cost per ton mile for coal, for instance, is greater. The cost for the train crew is less, and that is less because we are able to get a larger mileage per day out of our stock. Perhaps I might mention here that our train crew consists, with our express trains, of two men. The trains are formed of four cars 60 feet long, and sometimes five cars, but generally four cars with the express trains. There is one motorman, there is one guard. There are none of the numerous men that you carry in this country upon the different platforms. As soon as the express train starts, it is the duty of the guard to go forward into the motorman's compartment, so that he may be there to assist him should it be required. With regard to the stopping trains, we have three men, a motorman, a guard in the front baggage compartment, a guard in the rear baggage compartment, and we have a trouble which you have not got here, because we have two classes, third class and first class, and we have to handle the baggage which is brought by the ordinary passenger for any of the intermediate stations. The journey over our Southport line occupies thirty-seven minutes, and we stop fourteen times. We allow fifteen seconds for each stop, and that fifteen seconds is found to be sufficient to enable us to let in our passengers and to get in our baggage, and the public themselves open the doors on the platforms and shut them. We have been considerably assisted in getting our passengers in and out, by having issued in the first instance notices to the public requesting them to get in at the rear door of the train and to get out at the front door of the train. That request has been complied with in a very extraordinary degree, and it enables us to load and unload our trains within the prescribed time.

So far as the advantages of electrical equipment are concerned, one of the things

which led us to change from steam to electricity on this particular line, was the difficulty that we had at our terminal station at Liverpool in handling the large number of people who have to come in during the rush hours, and it is quite obvious that if you work into a terminal station with steam trains, every time a steam train comes in and goes out, you have four platform operations and eight signal operations. First of all the train comes in; then a locomotive follows it, that is two; then the train goes out, that is three; then the locomotive which brought it in goes out, that is four. That is four platform operations, which means eight signal operations. That all takes time. Now, with the electric train, you come in; that is one. The motorman goes to the other end of the train, the train goes out; that is two. You have only two platform operations, four signal operations. The result is that you double your terminal accommodation. In addition to that, it so happened that we had upon this particular line four tracks going out for a certain distance toward Southport. We were able, as a consequence of the electrification, to relinquish the use of two of those tracks and devote them to freight train service; but the number of passengers travelling has become so great, through the increase, that we shall have almost immediately to equip those tracks with the third rail and begin to use them partially again during the rush hours for passenger service.

So far as the original cost is concerned, it does not seem to be possible, dealing with a line such as that which Mr. Gerard has described, to run the service which he has given, — to run coaches such as we have, which are much larger than the coaches which you use upon your subway, say, in New York, and which are much more like main line coaches, — it does not seem possible to look forward to equipping such a line with electric traction for less than about £20,000 per mile, and that roughly, I think, represents something like three and a half times the cost of equipping it for steam traction. The result is, that when you come to add your operating costs to your interest and depreciation, there is no doubt that it will cost you more money per ton mile run, though you may very well get it back again by the very large increase in passenger traffic.

I want to repeat that it is not a question of saving money; it is a question of making money. (*Applause.*) Therefore the conclusion of Mr. Gerard's report, in which he says: "In England, on the lines where electric working is now in operation, the electrification is attended with an increase in the number of trains and consequently in the facilities offered to passengers," — I need not read all that, but I merely want to say that one's own conclusions agree with that.

Will you permit me to add, Mr. Chairman, that we do not find that the weight of what we may call the locomotive equipment of the train is any less than it would be with the steam locomotive; and dealing with main line work, there is no doubt that the aggregate weight of the motors, the controllers and the electrical equipment will, in almost every case, come to as much as, if not more than, the weight which would be required if the train were going to be hauled by a steam locomotive.

**The President.** (In French.) — We ought to be particularly obliged to Mr. Aspinall, because he has been very unwell and has left his room purposely to come and give us these particulars at this meeting. (*Applause.*)

**Mr. Ernest Gerard.** (In French.) — It was with the greatest pleasure that I listened to Mr. Schulz discoursing upon high speed electric traction, because I believe that opinions with regard to electric traction at ordinary speeds are already settled. But Mr. Schulz who belongs to the country which bred Wagner, whose music we hear is that of the future, comes also from a country where they have specially studied the traction of the future which I shall call the traction of *extra speed*.

I am not now considering the electrification of lines at present worked by steam where the speed is settled and the track is laid ; I am thinking of something new, not only as regards speed, but also as regards the track.

I must insist upon this point : to meet the needs of *extra speed*, the present track, if it suffices at all, will have to be strengthened to the utmost extent in its present constitution and even, I fancy, altered to a certain degree.

That such a speed could have been attained between Zossen and Berlin, I attribute in great part to the road.

I had the honour and the pleasure (I was the first stranger who had this honour and Mr. Schulz helped to obtain it for me) to be allowed to travel in one of the electric cars during a trial trip when the speed reached 207 kilometres (128·6 miles) an hour.

It was on the 20<sup>th</sup> October 1903. We had previously examined the track with great care.

The track was laid like this (*see diagram on the following page*).

You will notice that there is a space of 50 millimetres ( $1\frac{31}{32}$  inch) between the head of the bearing rail and the flat surface of the check-rail.

I asked myself what was the advantage of the check rail with which the track used for the experiments in the high speed electric traction was equipped. As a matter of fact, it helps very seriously and efficiently in preventing any increase in side-way oscillation when it begins to arise. To make sure of this, I made chalk marks on the flat surface and the result was what I expected, namely that the chalk was rubbed off to reappear further on ; I repeated similar experiments in other ways at other points and got similar results. This clearly demonstrates, I repeat, that the guard rail helps markedly in checking oscillation which had proved fatal in the experiments of the two preceding years.

Consequently we are entitled to affirm, that after having almost failed in the attempts carried out on an ordinary track, these Berlin gentlemen were quite well advised in strengthening their road in this manner.

One of my colleagues in the Belgian commission, has calculated the resistance of the materials constituting the track and he found that, in the vertical direction, the guard rail helped to increase the stiffness of the track by 50 per cent and, horizontally, in the ratio increased of 7 to 1.

The very great reduction, one might almost say the practical absence of deformation in the track, assists immensely in reducing to a minimum the mechanical resistance to traction.

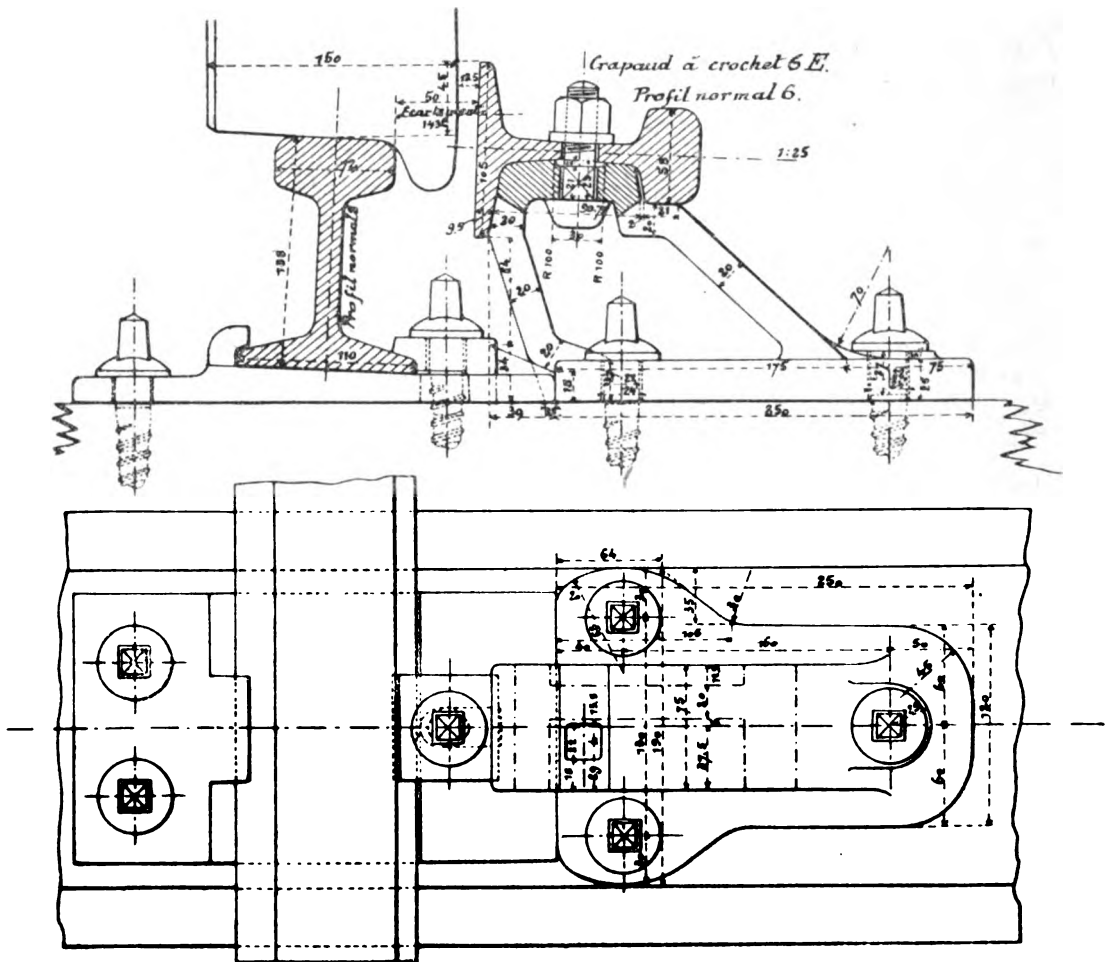


Fig. 1.

*Explanation of French terms :* Crapaud à crochet 6E = Claw-plug 6E. Profil normal = Normal profile.  
Écartement = Gauge.

Consequently, it seems to me proved that if such *extra* speeds are to be reached someday under working conditions, we shall have to find a method of strengthening by some expedient, to obviate the oscillating movements and decrease the resistance to traction, while at the same time increasing safety and comfort.

**Mr. Schulz.** (In German.) — I agree entirely with Mr. Gerard in stating that the side rails were very necessary. The second rail is of particular importance as giving a very great strengthening of the permanent way. During the experiments red color had been put on the side rails, and of course some of the red color was removed by the tires at certain points, but this was only in consequence of the oscillating movement. But, our engineers differed as to whether the side rails were necessary to prevent derailments. The future alone can determine definitely what will be necessary, and whether these side guard rails may prove superfluous.

I thank Mr. Gerard very much for his reference to our celebrated musician Wagner. I think if our trials with high speed electric railways should have similar success to that of Mr. Wagner, we should be very well satisfied. (*Applause.*)

**The President** (In French.) — Gentlemen, we have heard some very interesting information about traffic carried at extra high speed, but the reports deal more especially with the application of electricity to more moderate speeds. Mr. Aspinall has given us some details about the application of electricity in Liverpool. Cannot we have some data of this kind on trials carried out in other countries?

**Mr. Laurent,** Orleans Railway, France. (In French.) — Gentlemen, French engineers quite agree with the conclusions drawn up by Mr. Paul-Dubois and they have been accepted likewise by Mr. Gerard. It is stated therein that in individual cases, electric traction provides a good and economical solution to the problem propounded. Such was the case on the Paris & Orleans Company's line.

Our applications of electric traction on the Orleans Company were carried out in two stages. Five years ago, we first had to extend our main lines into the heart of Paris. Our Quai d'Orsay station, which some of you were able to view at the time of the last meeting of the Congress, is situated in the centre of Paris and is connected with the Austerlitz station by a tunnel. Our original intention was to do away with any locomotive in this tunnel that produced smoke. We were thereupon induced to consider the introduction of electric traction as compared with other methods of traction which caused as little smoke as possible.

Our attention was then drawn to the use of electricity in America, and, among others to the Baltimore and Ohio lines. Several of our engineers went out to study this and in conformity with the conclusions they reached, it was decided to use electric traction on the extension of our lines into Paris. The scheme was carried out about five years ago, and since then electric traction has been used for all our trains between the Austerlitz and Quai d'Orsay stations to our entire satisfaction.

Subsequently, owing to the needs of traffic, we have been induced to quadruple our main line in the neighbourhood of Paris and although we still have not any very heavy suburban traffic, we have considered whether, in view of the present conditions, and in view of our having a central generating station, it would not be beneficial to take advantage of this quadrupling and immediately equip with electricity two of these lines set apart for suburban traffic. The result of this enquiry, having

regard to the special surrounding circumstances, was that we decided it an advantage to use electricity.

We began using electric traction between Paris and Juvisy, a section of 22 kilometres (13·67 miles), on the 1<sup>st</sup> of last July. The trains are hauled either by the same locomotives that carry on the service of trains on our Paris extension between the Austerlitz and Quai d'Orsay stations, or by motor cars, the trains in this case being equipped with a method of control like ordinary motors. This service has been running for several months quite satisfactorily, both from a mechanical and economic standpoint.

Consequently, we entirely agree as to the ease with which electric traction may prove an advantageous solution in certain individual cases.

I have listened with much interest to the account of the remarkable experiments conducted in Germany, which moreover the whole world followed with equal interest.

As Mr. Gerard said, I think these experiments present a problem different from any that has so far been solved by the applications of electric tractions — I mean the problem of electric traction on main lines at high speed.

In listening to the very interesting figures provided, I could not help thinking that it seems clear from all that was said that these experiments proved that the use of electric traction at high speeds would necessitate the building of new lines or any way a complete renewal of the track. Furthermore, I think some side questions will have to come up for solution, such as signalling and braking which are relevant.

Lastly, I was struck with the gigantic resistance which increases with the speed.

If I correctly understood the figures recently quoted, cars weighing 90 tons and carrying 50 passengers require on the level 1,340 horse-powers for a speed of 190 kilometres (118 miles) an hour. Now our fast trains running at an average speed of 90 to 92 kilometres (56 to 57 miles) and which consequently at times do 105 and even 110 kilometres (65·3 and even 68·4 miles) an hour, hauled by locomotives of similar power, can accommodate as many as 400 first class passengers.

We should have, therefore, to anticipate enormous expenses in using very high speed electric traction and, besides the technical question which appears to have been thoroughly studied in Germany, the following question seems to me to arise : on what lines would it be advantageous to run such trains? Can we imagine that the advantage of increasing speed to such an extent, can justify the expenditure we anticipate in building these lines and running these trains?

I should be very gratified to receive any information that can be afforded on this subject.

We have seen in the papers suggestions of building several high speed lines, for instance a line between Liverpool and Manchester, one between Brussels and Antwerp, and lastly several lines in Germany.

Has the subject been considered from a financial aspect in the case of these projected lines?

**Mr. Ernest Gerard.** (In French.) — There is no idea of attaining extra high speed on the line projected between Brussels and Antwerp. There is only 44 kilometres (27·3 miles) between the two cities now, and the suggested route would also probably shorten the distance.

The problem to be settled in building this line between Brussels and Antwerp might be stated as follows : given two great cities with constant intercommunication, to connect by a sort of interurban tramway running at about 100 kilometres (62 miles) an hour. This service to be very frequent and the fare a little lower than the present full fare so as to provide, from the centre of one great city to the centre of the other, great facilities to passengers by giving them plenty of choice in the hour to start and ability to travel as suits them best.

**Mr. Schulz.** (In German.) — Answering the question raised by Mr. Laurent, I would say that for a speed of 200 kilometres (124·3 miles) entirely new lines must be constructed. The newly constructed lines must be quite independent. Of course they cannot have any level crossings. If such lines are to be built, of course great expense will be the consequence. It is indeed necessary to consider very seriously at which places such new lines for high speed may be constructed with good financial results. I think that in the beginning, they can only be constructed between large cities which have a great interchanging traffic between them. In Germany, application has been made to construct a railway of high speed between Berlin and Hamburg, and there are now two companies, Siemens-Halske and the *Allgemeine Electricitäts Gesellschaft*, who are asking the government for the right of way to construct that high speed railway, but the question is still pending. Good results can be hoped for by connecting two cities between which there is already so large a business. Experience has shown that great frequency of trains increases the traffic itself. The distance between Hamburg and Berlin is about 286 kilometres (178 miles). At present the fastest trains run the distance within three and a half hours. In future, using this high speed electric railway, the distance would be travelled within an hour and a half, and this increase of speed would of course increase the traffic, as experience has shown everywhere.

I regret that I am not able for the present to give any accurate details about the financial side of the question. I think it is very fitting to put this question here in the United States, because in the eastern part of this country the problem may come up of building a high speed railway, for instance, between Washington, Baltimore, Philadelphia and New York, because these large cities already have a very heavy interchange traffic; so I hope that by and by in the United States also this problem of high speed electric railways will be seriously considered.

**Mr. Sabouret,** French Western Railway. (In French.) — The Western Company of France has had occasion to put down an electric installation in the neighbourhood of Paris very similar to that which the Orleans Company has introduced for the Paris

and Juvisy line which Mr. Laurent just described. This installation was carried out between 1898 and 1900.

The current used for running the trains is a continuous 500 volt current obtained by transforming a primary triphase 5,500 volt current. The energy is therefore distributed as in the case of the Orleans Company and also on the Liverpool & Southport Railway.

Our line is 17 kilometres (10·6 miles) long and rises nearly 100 metres (328 feet) between Paris and Versailles. In Paris, the terminus is under the Esplanade des Invalides. Between Paris and Versailles, the line runs through a hill in a tunnel 3  $\frac{1}{2}$  kilometres (2·17 miles) long, with a steady rising gradient of 8 millimetres (1 in 125). On each side of the tunnel there is a long gradient of 10 millimetres per metre (1 in 100).

It was with a view to avoiding smoke in the station under the Invalides and in this long tunnel, that our company decided to employ electric traction on this line from the very commencement. The traffic is worked at present with ten electric 50 ton locomotives hauling ordinary rolling stock and besides with two automotor trains. These two trains, consisting of eight or nine cars, have an automotor in front, an automotor in the rear and if need be an intermediate automotor.

The motors are of different patterns; some have gearing and some have none.

Our trains run at fairly high speed, especially on the down gradient; the speed is as much as 80 and even 100 kilometres (50 and even 62 miles) an hour, and if we may judge from our four years experience, it would seem that at these high speeds the motors without gearing possess marked advantages over the single reduction or geared motors. The former are not fastened directly on to the axle; the armature is fixed on a hollow shaft which surrounds the fixed axle and acts upon it through an elastic coupling.

You will doubtless be interested if I give you a few details learnt by experience.

The motors were originally lubricated with thick grease; this method of lubrication gave us a great deal of trouble and so we substituted lubrication with mazout with very satisfactory results.

From a financial standpoint, the traffic is not exceedingly profitable.

At the busiest times in the day, we run three or four trains an hour in each direction. The current, as it leaves the generating station, costs 5 or 6 centimes (0·48 or 0·58 denier) per kilowatt-hour. Despite this fairly low figure and the comparative frequency of the service, electric traction costs us appreciably more than steam traction would.

The Western Company had thought of extending its electric plant, but we now think it advisable to wait a little longer before using electric traction on other lines in the neighbourhood of Paris.

**The President.** (In French.) — There are still several gentlemen desirous of taking part in this discussion. But as we have a general meeting at half past one, it will be

impossible for us to finish this debate this morning and pass conclusions. Consequently, I suggest that we adjourn till 9 o'clock to-morrow. (*Agreed.*)

— The meeting rose at 12.30.

---

**Meeting held on May 12, 1905 (morning).**

---

**Mr. Auvert, Paris-Lyons-Mediterranean Railway.** (In French.) — The Paris-Lyons-Mediterranean Company has for a long time been carefully considering the application of electric traction to railways; it has followed with much interest the investigations that have been carried out on this subject in France and abroad; it took a step in this direction in 1901 by equipping electrically the line between Fayet and Chamonix with automotor trains controlled by pneumatic servo-motors. But with its steep gradients and narrow-gauge, this line is very different to work as compared with main lines.

The method adopted, namely the multiple system, has proved quite satisfactory, but it cannot be regarded as a general solution of the question.

The Paris-Lyons-Mediterranean Company has long been carrying on investigations with a view to applying electric traction on a main line at present worked by steam; I allude to the line between Cannes and Vintimille, upon which trains of all kinds, fast trains, expresses and goods trains, are run.

Here the question assumes quite a different aspect.

We found that if we were to use the continuous current as applied on the Orleans and Western Railways, *i. e.*, on the Paris & Juvisy and on the Invalides & Versailles Railways, on the Fayet & Chamonix and also at New York and in Baltimore, we should be involved in enormous and prohibitive expenditure both in preliminary and running expenses.

For traction by continuous current with the third rail implies the use of low tension and very expensive conductors of large section, and necessitates the building of sub-stations. The latter are necessarily in use for short periods only and consequently their mean efficiency is low.

We have come to the conclusion that the application of electric traction is only practically feasible (so far as we are concerned, be it understood) if we use high tensions; these are only possible with alternating currents.

We have, therefore, considered a method of producing the monophasic alternating current at high pressure (12,000 to 15,000 volts) in a single generating station to supply a section from 80 to 100 kilometres (50 to 62 miles) in length. This generating station producing the monophasic alternating current would transmit the current to the motor cars which would be, as might be necessary, powerful loco-

motives like the steam locomotives and even a little more powerful. On these locomotives, the alternating current with *high constant* potential would be transformed into continuous current at a *pressure varying from zero up to a certain maximum* suitable to the satisfactory working of the motors similar to the ordinary pattern acting upon the axles.

The motors themselves would use continuous current. We prefer this method at least for powerful locomotives designed to haul express trains; for we think that continuous current motors are at present those which provide the maximum efficiency and, with a given current, produce the maximum power.

Another system consists in using the monophasic current directly on alternating current motors equipped with collectors, such as has recently been done by the Westinghouse and the general electric companies on some long distance tramways.

We intend to experiment with this method, but these alternating current motors possess the disadvantage of being more bulky than the continuous current motors. They might, therefore, be suitable for a service necessitating the use, not of high power engines, but of motor vehicles or locomotives of 500 and 600 horse-power, but they would hardly do for locomotives of 1,500 and 2,000 horse-power.

As we anticipate using two kinds of locomotives (high power locomotives for heavy passenger trains and low power locomotives for local trains to run the short distances between Nice, Cannes and Mentone), we have decided that, in the former case, we should use continuous current motors, this continuous current being obtained on the locomotives *themselves* by transforming the alternating monophasic current by means of special transformers of a novel pattern, and that in the latter case we should use alternating current motors of the American pattern.

I am speaking, be it understood, only of a project, and that is why I do not intend to say anything more on this subject.

**Mr. Alexander Wilson**, North Eastern Railway, Great Britain. — The experience of the North Eastern Company in the Newcastle district as regards electric traction has been substantially similar to that of the Lancashire & Yorkshire Company, described by Mr. Aspinall yesterday, so that I need not weary this meeting by repeating what he said. I gathered, however, from what Mr. Gerard let fall, that he was anxious to have some information as regards the cost of electric working in England. Now, this question is not altogether free from difficulty, especially when we come to compare steam with electric traction. In considering this matter, we must also have regard to this fact, that it is not possible to run so frequent a train service into and out of busy terminal stations by steam as can be done in the case of electricity. We are, therefore, able to secure greater efficiency and to take more advantage of our existing lines by means of electricity than by means of steam, and this is a factor which should always be borne in mind, because experience has proved that increased service and more efficient working have invariably resulted in an increased net receipt.

As regards the cost of working on the North Eastern system, it may be of interest if I give you one or two figures which I happen to have with me, and in doing so I should like to express the hope that I may be favoured with any similar information from delegates present, because to all students of this and other subjects comparisons are most useful, they are sometimes stimulating and always helpful.

The figures which I should like to present are these, and they relate solely to the question of the electricity consumed in running trains, its cost to us and the wages of the trainmen. I take the figures of the most recent month I have, *viz.*, February of this year, which by the way is a short month. The train miles run by the North Eastern in the Newcastle District was 92,541 miles. The car mileage was 254,938 miles; the number of cars per train amounted to 2.75; the units consumed amounted to 647,140 units; the units consumed per train mile, which is a most interesting figure, were 6.993; the units consumed per car mile amounted to 2.538; the cost of electricity per car mile amounted to 1.6*d.*; motormen's wages per car mile amounted to 0.297*d.*; the guards' wages amounted to 0.217*d.*, and the total cost of these three services per car mile amounted to 2.115*d.* So that the cost per train mile amounted to 5.7*d.* This, as I have stated, merely represents the running expenses, and regard is not had in the figures given, either to cost of maintenance of way or of equipment or to interest on capital and depreciation.

We find that we have to exercise the greatest care in endeavouring to keep down the car mileage, as it is by this means that we are able to keep the costs at a low figure.

As regards the observations of the last speaker, we find that the multiple unit system which we have adopted is quite satisfactory. It enables us to put on or to take off cars just as we require them, and on that score our experience has been, as I said, satisfactory.

**Mr. Moffre**, French Midi Railway. (In French.) — From the very interesting reports before us, we gather that electrical engineers are bending their energies towards utilizing the monophase current for electric traction. Unfortunately these reports are somewhat old, in that they date back several months, and in electrical affairs, a period of a few months is long enough for it to be possible that important improvements may have cropped up in the meantime. Consequently, it would be well if some American engineers would kindly tell us the latest developments in America.

We have heard of vehicles running on the trial lines at Pittsburg and Schenectady; but are there any cars with monophase alternating current carrying on a public service in America? I should be glad to get definite information on this point.

**Mr. Steinbiss**, German Government. (In German and in English.) — We have made experimental trials in Germany with electric traction, with continuous current, on the line from Berlin to Wannsee. We have also experimented with monophase

alternating current on the line from Niederschoenweide to Spindlersfeld. There the voltage is 6,000 on the line, transformed down to 600 in the motor. The motors are not geared directly on the axle, but with gears in the proportion of 1 to 4·26. Our experience with this system has been so satisfactory concerning economy, performance and safety, that we intend to use it on other lines. The trials began in 1903. The speed of the trains was from 40 to 60 kilometres (25 to 37·3 miles) an hour. The electric trains are run between the steam trains. The trains consist of one motor car, two motor cars coupled, or two motor cars and three trailers. These five cars, two motor cars and three trailers, represent a total weight of 150 tons (148 English tons). No accident has happened. This exceptionally good result on this trial track caused us to apply the monophase alternating current with collector motors on other tracks. Just now we are beginning to construct a new track for electric traction. That is a track from Blankensee to Altona and Hamburg, suburban traffic. The length of that track will be 26 kilometres (16·2 miles), the speed will be 60 kilometres (37·3 miles) an hour.

In the ordinary service, we shall form the trains of two cars. That will be the unit of the traffic service, and the two cars will have six axles, three to each car. Each car will have a truck forward and a single axle following, and the cars are coupled in 4-2-2-4 order. These two cars can take a load of from 100 to 110 passengers, all seated. We shall join some of these units, and we propose to run them with four or six cars so as to carry 300 passengers in one train. We expect to carry over that track 3,000 people in an hour in each direction. The trains will have three minute intervals at full service, and in ordinary service will follow one another at intervals of six or ten minutes. We are now constructing the power station and building the track. We hope to finish this work in the month of July next year, so that we may begin the experimental trials, and we hope to bring the track into public service with electric traction, monophase alternating current and collector motors, by the 1<sup>st</sup> of October of next year.

**Mr. Ernest Gerard.** (In French.) — I should like to know one thing from the speaker who has just sat down. Will the motors be geared or will they act directly on the axle?

**Mr. Steinbiss.** — They will be geared; the ratio will be 1 : 4·26.

**Mr. Ernest Gerard.** (In French.) — I must begin by thanking Mr. Wilson for the information he has kindly given us about the North Eastern Railway.

Most railway engineers who spend their time on electric traction are conversant with the progress of electrical engineering in so far as concerns traction, and they are in a position to estimate up to a certain point what electricity is capable of and how it can be used. The point that causes difficulty is, how to reply when questioned as to the ultimate cost of working which a railway company's board never fails to ask. To this question, the reply has to be guarded, and we have to resort to saying

that it is a matter dependent upon circumstances and that calculations must be made for each individual case.

Personally I am convinced that if all who have so far installed electricity would be kind enough, not now, but between this and the next session, to answer a list of questions drawn up with this object, they would be rendering a very great service to all who have schemes for electrifying their lines, and at the same time, they would be contributing largely to the general advance of the application of electricity to traction.

I hope then that for next session, a very strict and complete list of questions on this head will be drawn up.

The question I have just asked the last speaker is not an unimportant one, not only as regards the mechanical transmission of power between the motor and the axle, but also from the economic standpoint. On lines where stops are not frequent, the gearless motor is better than the geared and I was very pleased to learn that in America one of the latest locomotors built by the General Electric Company for the New York Central had no gearing.

When stops are very frequent and speed extremely high, gearing may prove very advantageous. It becomes not only useless, but expensive, when the opposite conditions prevail. The additional resistance which it involves must increase expenditure of current, and when this expenditure is multiplied by all the coefficients, from the car up to the generating station, one necessarily arrives at a serious increase in "first cost" — I use the English term because it seems to me more expressive than the French.

The third point I come across in my report and in the conclusions I have had the honour to bring before you, is that of safety. I have not had any opportunity of considering the subject of safety by comparing the conveyance of the current by an overhead wire and through the third rail. I intend to stick to the question of safety so far as concerns the third rail.

The methods of protection used in England, France, Germany and the United States are very numerous. The first question which arises is the kind of protection; a second is whether the protection ought to extend outside stations and whether it is advantageous to prolong it beyond the places where not only passengers but also employees pass. This means that we must consider several different zones with regard to protecting the third rail :

- 1° The station, in the part where passengers walk;
- 2° The station in parts where chiefly station employees walk;
- 3° The open track throughout its whole length.

I should be glad to learn the views of experts on these three points so that we might satisfy the very exacting officials as to where the third rail must be protected and where protection is unnecessary.

As regards the method of protection, that is a matter requiring judgment. There are various very efficient methods; it would be hard to find any more efficient than

the one we saw yesterday at Baltimore, where the third rail was so well hidden that it could scarcely be seen.

In conclusion, I repeat that the point on which I most desire information is not as to the method of protection, but as to the limits which may be assigned to the protection of the third rail.

**The President.** (In French.) — You have just heard, Gentlemen, the two questions upon which information is especially desired from American engineers. The first concerns the practical use of monophasé alternating current for regular working; the second concerns the views held and the regulations accepted for protecting the third rail.

**Mr. Laurent.** (In French.) — I shall try to reply at once to Mr. Gerard's question regarding the safety of the third rail, at least as far as our experience of it goes on the Orleans Company. In the second place I should like to ask another question in connection with the use of the monophasé current upon which I should much like to hear the views and results of experience from our American colleagues.

As regard the third rail, the Orleans Company first tried it on the extension of its lines in tunnel into Paris. Practically throughout, we covered in our third rail with wood. The shoes run along underneath this wood which completely encloses the third rail.

When we extended the use of electric traction on our suburban lines between Paris and Juvisy, we came to the conclusion that it was useless to cover in the third rail so completely throughout, especially considering what an expense it involved. We, therefore, confined ourselves to protecting the part within the stations, but by station I mean not only the part frequented by passengers, but also the part where the station employees have to go about.

On the line away from the stations, we have here and there thrown over the third rail a short wooden protection, so as to allow employees who in the course of their duties have to walk about the track to cross the lines by stepping on the wooden covering.

This is all we have done, and yet we think that we have taken unnecessary precautions, for no accident has occurred through the third rail. We certainly have had a few accidents, slight it is true, to mechanics employed in repairing electric locomotives owing to their having accidentally touched the third rail with iron tools; but not a single accident has happened through the third rail either to employees or to passengers. I believe that the only accident we have had, was caused by an overhead line. There are certain places in the Quai d'Orsay station where it is very difficult to lay a third rail owing to the crowding of switches; here, therefore, we were obliged to put overhead wires. A lamp-man, who was on the top of a carriage, came in contact with the overhead wire and that is the only accident — and that not a serious one either — we have to chronicle.

I conclude from this that our precautions are rather exaggerated and wha

supports my opinion in this respect is the experience of the Paris-Lyons-Mediterranean and Western Companies, which have adopted less thorough methods of protection without having any accidents to record.

I am very anxious to add one more question to those that have been asked. This question concerns the difficulties in connection with ice in using the third rail.

I may say that it is the only serious inconvenience we have found in using electric traction. Fortunately, with us, it happens very seldom; but two or three times our traffic has been interfered with because the third rail was covered with a coating of ice. So far, we have not succeeded in finding any means of avoiding this inconvenience quite satisfactorily.

Perhaps American engineers, who have had longer experience in electric lines with the third rail, will be good enough to tell us what means they take to avoid this inconvenience and with what results.

**Mr. W. D. Young, reporter.** — There have been several questions asked, Mr. President, as to the progress made or the status occupied by the single-phase system as it stands to-day in the United States. There can be but little said on this point, although more can be said than I was able to give in my report at that time. My report fully describes one of the first installations, and whereas promise was made at that time and every indication given of rapid advancement along those lines, I think we have simply gone through the experience that we usually go through; that is, we are disappointed inasmuch as these developments are a little slower than first anticipated; and this case is no exception to the rule in that respect. There has, however, in addition to the line described, the Ballston line to Schenectady (which has now been in daily operation, I believe, about one and one-half years, and no doubt a large number of your engineers who will take the trip will have an opportunity to see this line), an installation that has been in operation some weeks in the neighbourhood of Indianapolis; I understand it has been fairly successful; there is also a third installation that has now been in operation some months between Bloomington and Pontiac, in Illinois, and the line is some 28 miles in length, and has been fairly satisfactory. Unfortunately, there cannot be much detail given at the present time, but I do not think we have any reason to feel disappointed in this. The progress has been satisfactory and about as rapid as we could expect.

I might say a few words about the third rail. I do not think the third rail is as bad as originally painted. The Baltimore & Ohio Railroad, which company I represent, has passed through years of development along that line. The first electric installation was put into operation ten years ago this coming August. At that time, there was erected (it was very fully described by Colonel N. H. Heft in his report at Paris <sup>[1]</sup>) a system of overhead conductors that was erected at a very great

---

<sup>(1)</sup> Vide *Bulletin of the Railway Congress*, No. 5, May, 1900 (2<sup>nd</sup> part), p. 1453, and *Proceedings of the sixth session* (Paris, 1900), vol. IV, p. XIX-3.

expense and I can assure you it gave during the time it was standing a great deal of anxiety. There are several reasons. It was well built in the beginning but it necessarily had to be very heavy. That is, heavy considered from a trolley point of view. It was made up of Z bars 3 inches by  $\frac{3}{8}$  inch section, covered with a 12-inch coverplate and the trolley was held in this, a shoe-shaped arrangement which slid therein. At the time the conductor was constructed, I felt it was a mistake because at that time I had had the fortune of being associated with the General Electric Company in the first third rail installation in this country, and that was the intramural at Chicago in 1893 at the World's Columbian Exposition. That was eminently successful, but everybody seemed to feel that it had no place off an elevated structure. However, I was overruled in my ideas in connection with installing the third rail against this overhead construction and the latter was erected. We found that the varying conditions that had to be met in steam railroad practice, that is (this line extending over some 4 miles of double-track of the main line between Washington and Philadelphia, through the city of Baltimore), that there had to be changes made continually to the track, in order to meet the varying conditions. Naturally changes had to be made in the overhead structure which were carried out with extreme difficulty. Trains were passing at frequent intervals, and to handle this heavy work above passing trains and keep the structure alive so that the locomotives could be used, was not an easy matter. We made a great many changes which were necessitated by the change of tracks, additional switches, sidings, etc. This line extends about half of the way, through tunnels which are underneath Baltimore, and it was there that the greatest difficulty was experienced in maintenance of this overhead structure. The corrosion due to the sulphurous fumes from passing locomotives, corroded the structure very quickly; the anchor-bolts were quickly eaten off. We tried all possible means of protecting the anchor-bolts and the structure, and found that there was no successful solution other than the costly practice of making renewals. During the seven years that this overhead structure was in service, it was necessary to completely renew throughout the tunnel this trolley section. It is a double track tunnel and there were two trolleys, not exactly over the track centers, but placed slightly off center. There was no headroom to work with tackle, and whereas all of that section was renewed without interrupting the traffic and the current being on all the time, there were no men injured; I do not know why, I cannot understand, but outside of some occasional shocks they got along very nicely; my experience is that it is not the new man that gets caught, it is the experienced employee; it is the man who thinks he knows exactly what to do and makes a mistake. On account of these difficulties that I have mentioned, this over head structure was removed and some three years ago the third rail was substituted. There has been no one hurt on this rail. It is protected by a through scheme; that is, guard boards on either side of the rail projecting slightly above the head of the third rail. The protection could not be brought as high as we should like to have it, on account of clearance.

That is something that I should like to see discussed in this Congress, *i. e.*, the standard distance of placing the third rail from the running rail and its height. I will come back to this point later. The rail through the right-of-way or over the line is protected by these guard boards with the exception through the station; there the rail has been entirely covered and is reached through a slot, about a half-inch opening, the shoe passing through this slot makes contact with the rail. This covering was resorted to as an additional precaution, because in laying out this line it was necessary to meet the conditions as they existed then; *i. e.*, stations, etc., which were not built with a view to ever using the third rail or any electric system because that was a subsequent development. The solution on the Baltimore & Ohio, for that reason, was particularly difficult. We have two stations along this line in which the public could very easily come in contact with the rail. In one instance, Camden station — that is our southern terminal — the rail is placed on the outside and there it is not so objectionable, but at Mount Royal northern station, the passengers are compelled to cross the third rail and it was necessary to completely cover it with this wooden structure. In addition there were installed in connection with this system, through the stations and through the yard where the employees were liable to come in contact, a system of sectional switches. However, of this nothing much that is good can be said. We put in the best we could get as an auxiliary precaution. The switches work, but we have no guarantee that they will always work. Therefore, we place no dependence on them. Within the last year, it became necessary to extend; further supplement the present line through the northern station in which the passengers have heretofore crossed the third rail, and that was very easily solved by leaving the third rail open, not attempting to convey it through the station because it was desired to extend this line between the third rail first installed and between the station proper. We therefore coast some 700 feet, and it was experimentally worked out and found that it was easily accomplished. This, in my opinion, can be resorted to in many cases. In designing a station, it is easy to so arrange the third rail in such a way that the public are in no way endangered; that is, by elevated platforms allowing the passengers to pass; using an elevated platform on the ground and allowing the passengers to pass over an elevated structure and down between the tracks, completely eliminating any danger from that source.

**Mr. von Leber, Austrian I. R. Ministry of Railways.** (In French.) — That would mean stations specially arranged for their purpose.

**Mr. Paul-Dubois, reporter.** — Quite so.

**Mr. W. D. Young.** — The question was raised about the difficulty experienced with sleet. In this latitude, we do not experience quite as much difficulty as in some of the northern cities — Chicago, New York and Boston. However, if we did not have a solution for that, we should have some trouble. As a matter of fact, the

first two years we did have some difficulty. The sleet as it forms on the rail under the proper conditions, is like the rail itself; it cannot be beaten off and cannot be successfully scraped off. The Manhattan Railway Company have used very successfully, however, a series of scrapers which are nothing more or less than sheets of steel placed with a short space between, which are forced down against the rail by means of air pressure. I find, however, a much better remedy is the use of calcium chloride. We tried it for the first time this year. It is inexpensive and exceedingly effective. It has no bad effects on the rail that I have been able to observe. I was told in the beginning that it would have, similar to salt. We never attempted to use salt, but I desire to say that the use of calcium chloride has been most gratifying. The specific gravity can be varied according to the weather conditions and in that way meet any emergency, as changing the specific gravity changes the freezing point of mixture.

Coming back again to the distance of the third rail from the track. I should like very much to hear some discussion on that point. There has been a move here in America to reach some standard. We will reach it in the end as we did with the standard railway, track gauge 4 ft. 8  $\frac{1}{2}$  in., but not until we were compelled to do it and at a much greater cost in the end. Unfortunately the third rail is applied in many cases to lines that are operated by steam and a great many obstructions not only from the rolling stock but permanent obstructions are met, such as gusset plates in bridge construction, wall clearances, signal clearances, etc. The most serious is the matter of not being able to get sufficient clearance on account of tunnels. The result is that it is usually compromised in each case and every railroad sets its own standard. There seems to be a unanimity of opinion as to its height which is 3  $\frac{1}{2}$  inches, which I think can be considered as a standard. However, the distance from the gauge line of rail is one that has not reached any standard and I do not see any immediate prospect. The 3  $\frac{1}{2}$  inches works out very well. It gives sufficient clearance with shoes when dropped down to their minimum clearance, and it is not so high provided it is kept out far enough not to be hit by passing cars. The distance adopted by the Baltimore & Ohio is 31  $\frac{1}{2}$  inches, from gauge line to center of third rail. As I have stated, we simply adopted this because we went out as far as we could, we came in as far as we could. There did not seem to be any alternative. However, the various installations throughout the country have various varying gauge distances, and it seems to me of utmost importance and would be a most valuable thing if we could come to some understanding not only here in America but secure an international gauge for the use of the third rail.

**Mr. von Leber.** (In French.) — I hope to have the pleasure of reading Mr. Young's speech in full in the proceedings of the Congress. His speech deals with a large number of subjects of great practical importance.

What Mr. Young said about doing away with the overhead wire and substituting

a third rail interests us much in Austria. If I understood rightly, this would mean rather a number of alterations in the track. The overhead wire was a little heavy and costly and any alterations in it were very difficult.

This was the first reason — the main one — brought forward; but there is a second reason which is the predominant one in our case — I mean — the inconveniences arising from the continual repairs which are necessary to maintain the overhead wire in good condition.

In view of the remarks made by Mr. Young, it will be seen that the most practical solution, in the case of lines with fairly heavy traffic lies in using a third rail in place of an overhead wire.

This point is a capital one, especially for our Metropolitan Railway. As a matter of fact, the subject is now being discussed in Vienna, where the Metropolitan is going to be electrified.

The question is whether to have an electric wire attached to the roof of the tunnel, or a third rail fastened to the sleepers.

Allow me to insist on the practical side of the question, for to-day we are considering the practical question and not a question of the future.

Several matters have been dealt with. For instance, we have considered how the third rail is to be carried through the stations and whether the rail need be protected only in the stations or on the open line.

I agree with Mr. Laurent's views; in my opinion, it is only necessary to put a covering in the station and leave the third rail uncovered between stations.

But there are two kinds of protection; there is the complete protection by covering in the third rail; this is what has been done from the Orleans station right up to the Quai d'Orsay. A kind of elbow carried on the vehicle inserts itself into the space and makes contact with the conducting rail.

Another method consists in putting, on each side of the live rail, a plank of wood. This is what we have done in our experiments with electric traction in Vienna.

The protection consisting of two side planks does not prevent putting your foot on the rail. Protecting planks of every kind are a source of trouble when it is necessary to remove ice and snow. There are many difficulties in cleaning the third rail in winter. If unprotected it will be much easier to get rid of sleet, ice and snow.

I asked Mr. Young how they got rid of snow. He replied that in this respect there were no difficulties on his line. The snow was got rid of by the methods used with steam traction. On the other hand, ice and sleet prove a serious obstacle.

The same is true in Vienna. As regards planks along the rail there are two plans in vogue: either a plank is put on both sides of the third rail or there is a single plank. The latter method is followed in Berlin, an employee can cross the live rail by stepping on the plank.

Another advantage of the plank method lies in the avoidance of a short circuit if

an iron bar or anything else should drop on the bearing rail and touch the third rail when a train is passing.

This subject is then, I repeat, of high importance to us. Another point has been touched upon in Mr. Young's speech. He has told us that in stations there are necessarily breaks in the third rail.

Now, to cross these gaps in the third rail by drifting, does not appear to me without inconvenience and it is not to be recommended. We cannot avoid a train stopping at a certain point in consequence of signals. In individual cases it may be possible to prevent this, but as a rule, we must be able to start a train at any point.

At all places where there are switches or level crossings, there must then be an overhead wire so as to start if need be. This means a slight complication and I should like to hear the views of some delegates on the point.

On some lines in Italy, they have been content to rely on drifting; this is true between Milan and Varese and it acts satisfactorily; but as a rule, as I have just said, one ought to be able to start at any point on the road.

Experiments have been carried out in Vienna with a view to comparing geared motors with gearless motors. Six or seven years ago, we believed that to reach speeds of 50 to 60 kilometres (31 to 37·3 miles) an hour with electric traction it was advisable to put the motors direct upon the axles themselves. These motors are large and heavy, but they have the advantage of hauling satisfactorily. There is no shaking, and starting is not even felt. We experimented with a train of ten cars, eight of which were motors, on each of which there was a motor fixed direct on the axle, and the train ran well; but the cost was high.

We then decided to use geared motors usually built in the ratio of 3 or 4. This system is cheap and the motor is much lighter.

A number of experiments on these lines were made in Berlin.

**The President.** (In French.) — Allow me to remind you, Mr. von Leber, that this subject of motors has been fully thrashed out and that opinions differed upon the subject.

**Mr. von Leber.** (In French.) — I was not present when the meeting began, Sir, and I hope you will pardon me; besides, I have finished what I had to say and so I need say no more.

**The President.** (In French.) — Yesterday and to-day we have listened to a most masterly debate on the principles of electric traction, the circumstances under which it can be applied and to a large number of extremely interesting details.

But we must come to conclusions which summarize this debate, so that we may be enabled to submit these conclusions in good time to the general meeting.

If, therefore, no one has any further remarks that they are anxious to make, we ought to go on to consider our conclusions. Some of these might be partially

borrowed from those at the end of Mr. Paul-Dubois report, taking into account the opinions expressed by the other reporters, and the views that have been expressed during the discussion.

**Mr. Paul-Dubois, reporter.** (In French.) — I should like to add a few words so as to give you some information about the cost of electric traction on the Quai d'Orsay and Juvisy line.

The data published on this subject, as an appendix to my report, referred to the year 1903, a time when the section between the Quai d'Orsay and the Austerlitz station was the only one open for traffic. Since then, the line has been extended to Juvisy, making a total length of 19 kilometres (11·8 miles), and the number of train-kilometres has risen from 223,000 to over 500,000 (from 139,800 to over 310,700 train-miles) per annum. This has resulted in a considerably decreased expenditure in some directions and especially in drivers' wages, the staff being much better utilized than before. Consequently, the cost of electric traction with our trains, which weigh on the average 150 tons (148 English tons), has fallen to about 65 centimes per train-kilometre (10*d.* per train-mile). This includes station expenses, driving, electrical power, various lubrication and fuel expenses, maintenance and repairs, but does not include interest and sinking fund charges.

**The President.** (In French.) — The following are the conclusions which we have the honour to submit for your approval :

“ The sections recognize that electric traction should be considered at present as an important auxiliary of steam traction, being capable of handling certain portions of railway traffic with advantage and economy.

“ It is impossible, in a general exposition, to point out the exact service to which electricity can be most readily applied, the application being essentially a question of local conditions, each particular case requiring special study. In this study, there must be taken into account the expense of electrification, and the following points : first, condition of service — that is, the frequency and weight of trains; second, the physical conditions of the line, such as length, profile and plan. In comparing the expenses of operation by electricity and by steam, the interest and depreciation on the electrical installation must be considered.

“ The increase in revenue which the improvements in service will generally produce should also be given consideration. An important point in the use of electricity is the increase in the present station facilities resulting from the reduced number of movements in the stations by the use of electric traction.

“ From the information furnished to the sections, it would seem that with the third rail as now used, security can be assured under favourable conditions without it being necessary to cover or protect the third rail for its entire length.

“ The sections have heard with much interest the results experienced with high speed electric traction between Marienfeld and Zossen, and also of the tests and

first applications for traction purposes of the alternating monophase current in the motor. ”

**Mr. Ernest Gerard.** (In French.) — These conclusions are very complete; we find in them almost everything that was stated in the reporters' conclusions. I am not therefore, getting up to object to these conclusions but to ask for a slight addition. For, the last paragraph of Mr. Paul-Dubois' conclusions has been skipped, though it contains a great deal in the line and a half which it takes up : “ in any case the problem ultimately reduces itself to a financial and economic estimate. ”

If this is true of most things, it is especially true of the matter before us.

Perhaps I might be allowed to suggest that the wish I recently expressed might appear at the close of our conclusions and thus serve as a connecting link between this and the next session. I should much appreciate a decision in my favour by the section.

**Mr. Auvert.** (In French.) — One short remark upon the wording of the last paragraph in the proposed conclusions. If I am not mistaken, this deals with the use of the monophase current in the motor. I suggest that this phrase should be altered to read monophase current on the locomotive, for there are many ways of transmitting electric power from trolleys down to motors.

**The President.** (In French.) — To show our acceptance of the two remarks which have just been made, I suggest an addition in the following terms : “ The Congress thinks that it would be very advantageous, in the future, to have accurate details on the cost of electric traction. ”

**Mr. Thonet,** Société d'entreprise de travaux, Italy. (In French.) — Might we not say : “ at the next session ” instead of “ in the future. ”

Between now and next session there will be time to get all this information which seems an urgent matter in view of the advance realized and the numerous applications which may be effected.

**The President.** (In French.) — The last question was answered yesterday at the general meeting. It was stated most categorically that we could express wishes, but that in no way had we the slightest right to interfere in deciding the agenda for our next session. It was stated that the Permanent Commission would take into account as far as possible any wishes expressed, but the Commission reserves to itself absolute freedom to act as it chooses. It would, therefore, be useless in the first place and secondly it would be lack of courtesy towards the Permanent Commission, if we were to seem to suggest to it that we desire something or other at a definite moment.

**Mr. von Leber.** (In French.) — Gentlemen, I was present at the general meeting when this subject was discussed and any of you who were present will have noticed that I objected to the theory just alluded to by Mr. Sauvage. My ground for doing so rested on definite facts.

At the London meeting, half a question on which I was reporting was referred by the Congress to the next session. This decision was ratified by the general meeting. We were all of opinion that a vote such as this, passed by the general meeting, would at least force the hands of the Permanent Commission. The subject was subsequently discussed at a meeting of the Permanent Commission of which I happen to be a member, and there was a desire to alter the programme on this point. To this I formally protested saying that in my opinion, a vote of the general meeting, which reigns supreme, ought to be respected.

My demand was recognized, the London programme was accepted, and at the Paris meeting, the report which had been reserved was discussed.

I ought, however, to remark that there is a great difference between a vote passed by the general meeting and a vote passed by a section.

We might express a wish that this subject should be put on the agenda paper for next session and the general meeting will support this wish if it chooses.

**The President.** (In French.) — Without wasting time over a formal question, we might I think proceed at once to the fundamental question.

I question whether we are quite ready to express a wish that the next session should make a special subject of the cost of electric traction. Undoubtedly this matter interests us much, but there may be many others and perhaps we should be sorry if we found ourselves tied and bound by the wish we might express now.

I should also like to ask the originator of the proposal himself, if he does not share my views on the subject. It would no doubt be interesting to possess the information in question, but ought we to make such a suggestion formally?

**Mr. Ernest Gerard, reporter.** (In French.) — I agree with what our President has said and as a member of the Permanent Commission, I will endeavour to see that the desire expressed shall bear fruit. (*Hear, hear.*)

**Mr. Thonet.** (In French.) — Under these circumstances I withdraw my proposal.

**The President.** (In French.) — To meet the second remark that was made regarding the alternating monophase current, I suggest that we should alter the conclusions in the following manner :

“ The sections recognize that electric traction should be considered at present as an important auxiliary of steam traction, being capable of handling certain portions of railway traffic with advantage and economy.

“ It is impossible, in a general exposition, to point out the exact service to which electricity can be most readily applied, the application being essentially a question of local conditions, each particular case requiring special study. In this study, there must be taken into account the expense of electrification, and the following points : first, condition of service — that is, the frequency and weight of trains; second, the physical conditions of the line, such as length, profile and plan. In comparing

the expenses of operation by electricity and by steam, the interest and depreciation on the electrical installation must be considered.

\* The increase in revenue which the improvements in service will generally produce should also be given consideration. An important point in the use of electricity is the increase in the present station facilities resulting from the reduced number of movements in the stations by the use of electric traction.

" From the information furnished to the sections, it would seem that with the third rail as now used, security can be assured under favorable conditions without it being necessary to cover or protect the third rail for its entire length.

" The sections have heard with much interest the results experienced with high speed electric traction between Marienfeld and Zossen, and also of the tests and first applications for traction purposes of the alternating monophase motors in several countries.

" Finally, the sections recommend that on account of their future usefulness exact data on the cost of electric traction be obtained. "

— These conclusions were unanimously adopted.

**The President.** (In French.) — The business of the section is now over.

In conclusion and before adjourning, let me thank you all for the attention and zeal with which you have kindly followed our discussions. Thanks to your energy and your extreme courtesy you have made the task a very pleasant one to your officers and to your President in particular.

I wish to thank you most sincerely for your help. (*Applause.*)

**Mr. J. E. Muhlfeld,** Baltimore and Ohio Railroad. — Gentlemen of the section, I think it is in order that we pass the following resolution :

" Resolved that the members of this section extend to Mr. Sauvage and the secretaries their sincere appreciation of the able manner in which they have handled all subjects, discussions and conclusions relating to the questions that have been brought before the section, either independently or jointly, for their decision. "  
(*Applause and unanimous approval.*)

**Mr. von Leber.** (In French.) — I suggest that we extend this vote of thanks to our officers and also to those who have undertaken translation and by so doing have rendered services of great value to the section. (*Applause.*)

**The President.** (In French.) — I am much touched by the kind words Mr. Muhlfeld has just said. I thank you for the unanimous way in which you have approved of them.

The thanks you have expressed to our secretary-translators at Mr. von Leber's suggestion are, I must say, thoroughly deserved. I can assure you that these gentlemen have often had to work very late and that they have not seen much of the town

of Washington. Nor have they been able to take part in the splendid excursions organized for our benefit.

To them is due especially the credit of having in a suitable and durable manner translated all the work that has been done throughout this session. (*Applause.*)

— The meeting rose at noon.

## DISCUSSION AT THE GENERAL MEETING

---

Meeting held on May 13, 1905 (afternoon).

---

MR. STUYVESANT FISH, PRESIDENT, IN THE CHAIR.

GENERAL SECRETARY, MR. L. WEISSENBRUCH.

ASSOCIATE GENERAL SECRETARY, MR. W. F. ALLEN.

The President read the

### Report of the 2<sup>nd</sup> and 5<sup>th</sup> sections meeting jointly.

(See the *Daily Journal of the session*, No. 4, p. 71, and No. 10, p. 216.)

“ The reporters, Messrs. F. PAUL-DUBOIS, ERNEST GERARD and W. D. YOUNG each read an abstract and the conclusions of their reports.

“ One of the secretaries also read the conclusions of Mr. V. TREMONTANI, who was absent.

“ Mr. SCHULZ (*German Government*) gave some information on the experiments made in Germany with high speed electric traction, to which some of the reporters had referred. Mr. Schulz explained that the object of these experiments was to determine scientifically if high speed electric traction were possible and satisfactory on main railway lines. In a great number of trial runs speeds of 200 to 210 kilometres (124 to 130·5 miles) per hour were attained, which are much higher than those previously reached. The experiments have shown that the ordinary type of superstructure, properly strengthened, would completely suffice for speeds of 200 kilometres (124 miles) per hour and more, and that, on the other hand, the general arrangement of express passenger cars is well adapted to great speeds, provided the wheel base be sufficiently increased.

“ Because of the great amount of energy to be transmitted to the motors, it had been found convenient to use the three-phase current with a tension of 10,000 to 12,000 volts.

“ The current was transmitted by three copper wires of 100 square millimetres (0·155 square inch) sectional area each, placed one above the other in a vertical plane, on one side of the permanent way. The bowl-like pole for taking the current was very light and provided with double acting springs which pressed the pole against the wires with a sufficient pressure to assure a good contact at the highest speed. The experiments have shown that it is thus possible to transmit a great amount of energy to an electric car going at a high speed. The arrangements used have, in fact, permitted the transmission of as many as 2,000 kilowatts to cars going at a speed of almost 60 metres (197 feet) per second, and this under unfavourable atmospheric conditions.

“ The experiments have also shown that three-phase motors were well adapted for high speed traction on main lines. The starting resistances, liquid or metallic, have worked well.

“ In all observations, special care was taken to determine the speed in an exact manner. The trial cars were furnished for this object with special apparatus of the Morse type.

“ The measurement of the total resistance to traction has given the following results : The resistance due to friction which is only 1·5 kilogram per ton (3·36 lb. per English ton) at a speed of 5 kilometres (3·1 miles) per hour increases gradually with the speed and becomes 3 kilograms (6·72 lb. per English ton) at a speed of 200 kilometres (124 miles) per hour. The resistance due to the air increases much more rapidly than the speed; and, it may be said, that it is this resistance which really limits the speed which may be realized. The resistance of a trail car is much less than that of the first automotor car, so that it is more economical to make up the trains of several cars than to run single automotor cars at short intervals, though the latter system is more satisfactory from the public point of view.

“ With a slowing down of  $1\frac{1}{2}$  metre (4·92 feet) per second, which can be realized without danger to the passengers, trains running at a speed of 160 to 200 kilometres (100 to 124 miles) per hour can be stopped in a distance of 650 to 1,000 metres (710 to 1,094 yards), respectively.

“ At speeds higher than 120 kilometres (74·6 miles) per hour, the signals could not be seen during bad weather in sufficient time. This has been improved by means of an electro-magnetic arrangement which places a red disk before the eyes of the motorman if the signal in front of him is at ‘ danger ’.

“ More than 300 trial runs were made without any accident.

“ Mr. Schulz held that this opens a great field to railroad engineers and electricians, and he expressed the wish that the operation of a high speed electric railroad may soon become an accomplished fact.

“ Mr. J. A. F. ASPINALL (*Lancashire & Yorkshire Railway*) gave some additional details on the electric line from Liverpool to Southport. Electric traction was not adopted on this line for the sake of economy, but to increase the receipts. Since

the twelve months during which the line has been operated electrically, the results have been most satisfactory as to increase in traffic, but the operation is more expensive than with steam. The cost of coal per ton mile especially is greater; the running expenses, however, are less because of the greater mileage run by the crews. Mr. J. A. F. Aspinall added that the train staff of express trains (made up of four and sometimes five cars) consists of a motorman and a conductor, who stays during the run in the motorman's compartment; that of local trains consists of a motorman and two conductors. The service is complicated, owing to the fact that it has two classes and considerable baggage to transport.

" The run from Liverpool to Southport takes thirty seven minutes, including fourteen stops of fifteen seconds each; passengers open and close the doors themselves; the boarding and leaving is done very rapidly owing to the special arrangement of the entrance and exit doors.

" One of the reasons for introducing electric traction on the line was the necessity of decreasing the crowding of the Liverpool terminus during the busy hours: the handling of an inbound steam train and its re-dispatching requires four distinct switching operations and eight signal operations, while for an electric train two switching and four signal operations are sufficient.

" The line has for a certain distance four tracks, two of which are at present used as freight tracks; the latter are to be equipped electrically and will be partially utilized for passengers during the busy hours because of the increase in traffic.

" The cost of the electric installation on the Liverpool and Southport line was as high as 20,000 pounds sterling per mile, or about three and one-half times the installation of a steam locomotive service. If the interest and sinking fund charges of this sum are added to the cost of operation, it is not surprising that electric traction costs more than steam.

" Mr. J. A. F. Aspinall added that the weight of electric equipment of the trains on the Liverpool-Southport line is not less than the weight of corresponding steam locomotives, and that the same will hold true for trains on main lines.

" Mr. Ernest GERARD supplied some data collected by himself and two of his colleagues on the Belgian State Railways about the Berlin-Zossen trials at which they were present and about the guard rail with which the road was equipped, with special reference to the external resistance to traction. Mr. SCHULZ held that a guard rail is especially important because of the strengthening of the track which it affords, but it did not appear to him necessary for the prevention of derailments; the opinions on this subject were, however, divided and experience only will decide whether the guard rail is useful or not.

" Mr. Th. LAURENT (*Orleans Railway*) stated that he was in full accord with the conclusions of Mr. Paul-Dubois' report as to the fact that electric traction under present conditions offers a successful solution of problems presenting themselves in some particular cases. The Orleans Company has used electric traction in one of

these particular cases, as has been described in the above mentioned report : this was in the case of a line through a tunnel into Paris — that is, a suburban traffic line. This line gives full satisfaction to the company.

“ On the other hand, Mr. Th. Laurent held, with Mr. Gerard, that the very interesting communication by Mr. Schulz touches a completely new and different question, that of high speed traction on main lines. It may be said that the whole world has followed with the greatest interest the experiments made in Germany, and Mr. Laurent felt obliged to Mr. Schulz for the details furnished on the subject. But, while listening to these details, he was struck by the fact that if the experiments made in Germany are of the highest interest from the technical point of view, it also results from them, that the use of very high speeds on railroads will cause enormous expense. It requires, in fact, a special track construction to permit speeds of 200 kilometres (124 miles) per hour; moreover, with this speed questions of braking and signalling arise. It, therefore, appears that entirely new and specialized tracks will have to be built for high speed trains. On the other hand, one is struck by the enormous increase in the consumption of the energy required for high speed; thus, not less than 1,340 horse-power are required to maintain a speed of 200 kilometres (124 miles) per hour, on a level stretch, for a single motor car weighing 90 tons (88.6 English tons) and containing 50 seats. The cost of this consumption is enormous, when it is remembered that in the high speed trains of the Orleans Company, 1,200 to 1,300 horse-power engines are sufficient to pull trains containing about 400 first-class passengers at a speed of 100 to 110 kilometres (62 to 68 miles) per hour. The question may then be asked whether, after the technical problem has been solved, the economic problem can also be considered as admitting of solution. Is it possible to conceive that the desire to establish a train service with very high speed should some day justify the enormous expenses of installation which will be required for this purpose? In some publications, mention was made of the intention to establish such a line between Brussels and Antwerp and between Liverpool and Manchester. Mr. Th. Laurent asked whether this was so and whether the question was studied from the economic point of view, including interest on capital. He would be pleased if some of the members present would inform him on this subject.

“ Mr. Ernest GERARD replied, as to the projected electric line between Brussels and Antwerp, the length of which is 44 kilometres (27.3 miles), that there is no intention to obtain on this line very high speeds; the object is rather to create an interurban service with very frequent trains and with low fares.

“ Mr. SCHULZ stated that, as far as Germany is concerned, the question is being discussed of establishing high speed electric lines between Berlin and Hamburg. He agreed with Mr. Laurent in thinking that an enterprise of this kind would be very costly, as it would require a completely new line because of the dangers which would result from the difference in speeds of trains running on the same track; it

would also be necessary to abolish all grade crossings. But a proof, however, that projects of this kind are practical is that two great German electrical construction companies are trying to obtain the concession of the Berlin and Hamburg line. The distance between these two cities, which is 286 kilometres (178 miles), and is at the present time run in three and a half hours, will be covered in an hour and a half. It is probable that considerable increase in traffic will result. Mr. Schulz stated, however, that he could not, at the present moment, furnish precise information on the financial question, and he asked whether the establishment of a line of this kind between Washington, Baltimore, Philadelphia and New York would not be profitable.

“ Mr. SABOURET (*French Western Railway*) contributed details on the electric installation on the line from the Invalides to Versailles, similar to those on the line from Paris to Juvisy. The main reason which has induced the French Western Railway Company to introduce electric traction on this line, is the existence of a terminal station at Paris which is partially underground and of a tunnel  $3\frac{1}{2}$  kilometres (2·2 miles) long on a continuous grade of 0·8, where it was necessary to avoid smoke.

“ Ten electric locomotives and two automotor trains are in service on this line with different types of motors, some geared and some not geared. At the great speeds (80 to 100 kilometres [50 to 62 miles] per hour) which the trains acquire while descending, the ungeared motors, the armatures of which are mounted on a hollow shaft, engaging the wheels in a yielding manner, offer important advantages over the geared motors. It has also been stated that the “mazout” lubrication is better than the American way of lubricating with grease.

“ This service consists of four to five trains per hour in either direction, and while the kilowatt-hour does not cost more than 5 to 6 centimes (0·48 to 0·58 penny), at the power station, the cost of operation of electric traction is noticeably higher than that of steam traction.

“ Mr. AUVERT (*Paris-Lyons-Mediterranean Railway*) stated that his company has been for a long time considering the question of electric traction. It has introduced in 1901 this system on the Fayet to Chamonix line with automotor trains.

“ This line operates under special conditions, because of very steep grades, and the solution adopted for it, while giving full satisfaction, cannot be considered to be a general solution.

“ The question acquires another aspect for the line from Cannes to Vintimille, for which electric traction has been considered for a long time. Studies made on this subject have shown that by using the continuous transformer current as on the lines Paris to Juvisy and Invalides to Versailles, the costs of installation of the third rail and sub-stations would be prohibitive. The use of electric traction has not been regarded as possible except by using a very high tension by means of alternating currents

" The present project includes the use of the alternating monophase current at 12,000 to 15,000 volts, generated in one power house and distributed directly to the motor cars on which the current with a constant tension will be transformed into a continuous current with the tension varying from 0 to a certain maximum, in order to be utilized in motors of the ordinary type acting upon the wheels. Mr. Auvert prefers this solution, at least for powerful locomotives designed to haul express trains, because continuous current motors give a maximum of efficiency and power for a given volume. He intends to try, at the same time, monophase motors with alternating current, but as these motors are cumbersome, which makes their use difficult for high power, Mr. Auvert hopes to adapt them to lighter locomotives designed to pull local trains.

" Mr. A. WILSON (*North Eastern Railway, England*) gave some information on the use of electric traction on the suburban lines of Newcastle-on-Tyne. He also furnished some data on the cost of operation of these lines, mentioning, however, the difficulty of making comparisons with steam traction. Electricity permits a better utilization of the existing lines and experience shows that the improved service which follows generally leads to increased receipts.

" The cost of electric traction for the month of February, 1903, was as follows :

" Mileage of trains . . . . .	92·541
" — of cars . . . . .	254,938
" Average number of cars per train . . . . .	2·75
" Total energy consumed (kilowatt hours) . . . . .	647,140
" Energy consumed per train mile (kilowatt hours) . . . . .	6·993
" — — per car mile (kilowatt hours) . . . . .	2·538
	Pence.
" Average cost of power per car mile . . . . .	1·601
" Driver's pay per car mile . . . . .	0·297
" Conductor's pay per car mile . . . . .	0·217
" Total cost of traction per car mile . . . . .	2·115
" — — per train mile . . . . .	5·7

" Replying to an inquiry from Mr. MOFFRE (*French Midi Railway*), who wished to know whether monophase alternating current motors have been applied to traction in the United States or elsewhere, Mr. STEINBISS (*German Government*) said that in addition to the trials made in Germany with electric traction by continuous current motors (for instance, on the Wannsee Railway), some monophase motors have been in operation since 1903 on the Niederschoeneweider-Spindlersfeld line near Berlin. The motors employed are of the Winter-Eichberg system; the speed is from 40 to 60 kilometres (25 to 37 miles) per hour; trains are made up of one or two automotor cars, with or without trailers; the heaviest train consists of five cars and weighs 150 tons.

" Encouraged by the results of this trial, German engineers are applying the

same system to a line connecting Hamburg, Altona and Blankensee, which is 26 kilometres (16 miles) long. The trains in ordinary service will consist of two cars, with three axles each (one two-axles truck and one independent axle), with a total of 100 seats; these trains will be run at a speed of 60 kilometres (37 miles) per hour, with three minute intervals between trains. The work of equipping the line has been begun; it is to be opened to traffic October 1 of next year.

“ Mr. Ernest GERARD, reporter, called attention to the importance of the question of the net cost of electric traction, and asked that this question be placed on the programme of the next session of the Congress. He then considered the question of the mechanical connection between the motor and the axle, and expressed the opinion that motors without gearing are better than geared motors, where few stops are made. He finally inquired whether any of the members could furnish information as to the utility of protecting the third rail, either at parts of stations accessible to passengers, or at places where railways employees have to walk on the tracks or over the entire length of lines operated by electric traction.

“ Mr. Th. LAURENT replied that on the Orleans Railway, the third rail is protected for its whole length within the city limits of Paris, only on account of the tunnels. Outside the city, the protection of the third rail is limited to stations, not only at points accessible to passengers, but also at places where employees may pass. It was his opinion, moreover, that the precautions taken were somewhat overdone; no serious accident due to the third rail had occurred since the line was opened to traffic.

“ Mr. W. D. YOUNG, reporter, said, in the first place, that he could give more complete data on the subject of monophasic motors than were contained in his report. Since this report was written two lines equipped with this type of motor have gone into operation in the United States — one near Indianapolis and the other between Bloomington and Pontiac, Ill.

“ As for the third rail, he did not believe it was as dangerous as people said. Ten years ago there was installed in Baltimore, to avoid the third rail, a system of overhead wiring, which proved very expensive and gave a great deal of trouble, particularly in the tunnels, which extend over half the length of the line; the corrosion caused by the sulphurous smoke and vapors from the locomotives finally made it necessary to rewire this line throughout. As all the changes and repairs had to be made without interrupting the service, and working with live wires, the expense was very great. Consequently his company decided three years ago to replace this overhead wiring with a third rail. This third rail is protected between stations by guard boards; at stations it is entirely enclosed, leaving a slot on top for the contact shoe. As an additional measure of safety, a system of automatic current breakers has been installed at the stations and at points where the workmen most frequently cross the tracks, but this system works irregularly and, therefore,

is not very reliable. Last year, the line was extended across the North Baltimore station; where passing this station the third rail has merely been omitted for a distance of 700 feet over which the trains are carried by momentum. In a new station, all danger could be avoided by using elevated platforms.

“ In reply to a question put by Mr. Th. LAURENT, Mr. W. D. YOUNG explained the means employed in America to prevent trouble from sleet on the third rail. The Manhattan Elevated Railway Company uses for this purpose, and apparently with success, scrapers held against the rail by compressed air. Mr. W. D. Young prefers using a solution of chloride of lime, regulating the density to the temperature, which is very cheap and entirely efficient.

“ Finally, Mr. W. D. Young pointed out the importance for the different railroad companies of arriving at a definite agreement on the question of the location of the third rail. On the Baltimore & Ohio Railroad, the horizontal distance between the axis of the third rail and the axis of the track rail nearest to it is  $31\frac{3}{4}$  inches; the height of the third rail above the track rail is  $3\frac{1}{2}$  inches. This height is almost the same everywhere, but the horizontal distance varies much with the different companies, and it would be very desirable to make these dimensions uniform.

“ Mr. VON LEBER (*Austrian Government*) found the reasons which had led the Baltimore & Ohio Railroad to replace the overhead trolley by the third rail, very interesting; at Vienna the question is at present being discussed, in view of the electrification of the Metropolitan. As to the protection of the third rail he agreed with the opinion of Mr. Th. Laurent that it is useful at stations only. He preferred the complete protection used on the Orleans Railroad to the protection afforded by two side planks, which would not prevent stepping on the conducting rail and make the removal of snow more difficult.

“ The method of passing by momentum the distances between the ends of the third rails did not appear to him without inconvenience.

“ He, finally, stated that experiments were made in Vienna to compare geared motors to ungeared motors; he preferred the latter.

“ Mr. F. PAUL-DUBOIS, reporter, desired to supplement the information given by him in his report on the subject of electric traction on the line Paris to Juvisy. Since the extension of electric traction to suburban traffic, the annual kilometric run of electric trains has increased from 225,000 to more than 500,000 kilometres (from 139,800 to more than 310,700 miles), and the cost of the traction per train kilometre has decreased to about 65 centimes (10 pence per train-mile).

“ The section noted besides a letter from Messrs. Rota and Grismayer, delegates of the Italian Government, objecting to the view expressed by the author of report No. 4 on the polyphase current systems, and promising to send the Permanent Commission details about the latest results obtained on the Valtelina line.

“ Finally, it decided to print, as an appendix to the discussion, a note by Mr. C. de

Gulácsy, delegate from the Boldva Valley Railway, containing some remarks about Mr. Tremontani's report.

" After an exchange of opinions, in which took part Messrs. Ernest GERARD, AUVERT, THONET (*Société d'entreprise de travaux, Italy*), VON LEBER, the PRESIDENT put to the vote the following conclusions which were unanimously adopted. "

**The President.** — The following are the

#### CONCLUSIONS.

" The Congress recognizes that electric traction should be considered at present as an important auxiliary of steam traction, being capable of handling certain portions of railway traffic with advantage and economy.

" It is impossible, in a general exposition, to point out the exact service to which electricity can be most readily applied, the application being essentially a question of local conditions, each particular case requiring special study. In this study, there must be taken into account the expense of electrification, and the following points : first, condition of service — that is, the frequency and weight of trains; second, the physical conditions of the line, such as length, profile and plan. In comparing the expenses of operation by electricity and by steam, the interest and depreciation on the electrical installation must be considered.

" The increase in revenue which the improvements in service will generally produce, should also be given consideration. An important point in the use of electricity is the increase in the present station facilities resulting from the reduced number of movements in the stations by the use of electric traction.

" From the information furnished to the Congress, it would seem that with the third rail as now used, security can be assured under favorable conditions without it being necessary to cover or protect the third rail for its entire length.

" The Congress has heard with much interest the results experienced with high speed electric traction between Marienfeld and Zossen, and also of the tests and first applications for traction purposes of the alternating monophasé motors in several countries.

" Finally, the Congress recommends that on account of their future usefulness exact data on the cost of electric traction be obtained. "

**The President** read the following telegram from the Italian Minister of Public Works :

Rome, May 5, 1905.

*To the President of the International Railway Congress, Washington, D. C. :*

" The imminent inauguration of the new regime in the State Railroads necessitates the presence in Rome of the officials delegated to the Congress. I therefore regret to state that they will not be able to be present at Washington. Kindly accept, however, the strong sympathy and the good wishes of

“ the Italian Government, which would have deemed itself honored to be represented. I should also  
“ like to state that the delegates, while reserving to themselves the transmission of a detailed report to  
“ the Permanent Commission at Brussels, send you a statement concerning question VIII <sup>(1)</sup>, in order to  
“ acquaint you with the recently completed researches on electric traction with the three-phase current  
“ on the Valtellina Railroad, which prove that this system, contrary to the conclusions of the reporter,  
“ may often give very satisfactory results. ”

CHARLES FERRARIS,  
*Minister of Public Works,*

— The general meeting accepted the conclusions submitted by the combined  
2<sup>nd</sup> and 5<sup>th</sup> sections.

---

(1) See Appendix II.

# APPENDICES

---

## APPENDIX I.

---

### Corrigenda to the report No. 2, by Ernest Gerard.

---

Page 987 of the *Bulletin* of February, 1905, 2<sup>nd</sup> part (page VIII-105 of the separate issue No. 36 and of the *Proceedings*), lines 10 and 11 from the bottom, *instead of* : " We may add that the speed has exceeded, by 15 miles per hour, that which was usual (20 miles per hour) when steam traction was used ", *read* : " We may add that the speed has been increased from 15 miles per hour, which was usual, to 20 miles per hour when steam traction was used ".

---

APPENDIX II.

**Letter from C. Rota and E. Grismayer  
on Mr. Victor Tremontani's report No. 4.**

Rome, April 30, 1905.

*Sir,*

We, the undersigned delegates of the Italian Ministry of Public Works to the seventh session of the International Railway Congress, who were unable to attend as we were detained by very urgent business at home, have the honour to submit the following communication to you :

In report No. 4 on subject VIII (Electric traction) the reporter has made statements, of a general character, on polyphase current systems of electric traction for railways, which would lead to unfavourable conclusions as to such systems of traction. In this connection, we the undersigned wish to remark that the reporter was not in a position to take into consideration the results of the three-phase current installations on the Valteline section of the Italian railways operated by the *Società delle Strade Ferrate Meridionali*. These results, which were obtained in the course of work only recently completed and not yet brought before technicians generally, lead to the conclusion that the system of traction by three-phase current gives, in some cases, a satisfactory solution from the technical as well as from the economic point of view.

A knowledge of these results might lead the Congress to modify its conclusions on the subject in question. It is for this reason that we, the undersigned, unable owing to lack of time to send a detailed report supporting this statement, venture to ask the Congress to take note of it; and that we propose, at a later date, to send a detailed report to the Permanent Commission at Brussels, so that it may be made the subject of discussion at the next session of the Congress

We have the honour to be, Sir,

Your obedient servants,

C. ROTA,  
*chief inspector of railways.*

E. GRISMAYER,  
*inspector of railways.*

*The President of the seventh session  
of the International Railway Congress,  
Washington.*

### APPENDIX III.

---

#### Remarks on Mr. Victor Tremontani's report No. 4,

By COLOMAN DE GULÁCSY,

PRESIDENT OF THE BOARD OF THE BOLDVA VALLEY LOCAL RAILWAY.

---

As the state of my health prevented me from going to America and taking part in the meetings of the International Railway Congress, I send in writing my remarks on Mr. Victor Tremontani's report on subject VIII (electric traction); a copy of his report has kindly been forwarded to me by the General Secretary of the Congress.

My remarks are chiefly based on the observations made on the Lecco-Chiavenna-Colico-Sondrio line of the *Società della Strade Ferrate Meridionali*, from September 4, 1902, when that line was opened to traffic, till the present day. The electric traction equipment of this line was supplied by Messrs. Ganz, of Budapest.

Mr. Tremontani's report deals with the development of electric traction between 1900 and 1905, and considers more especially the progress made in Italy in this connection. After a short account of previous trials and attempts, he enunciates in a general manner the advantages of electric traction as against steam traction, and makes an interesting comparison between the two methods of traction.

I do not wish to consider in this place the definite and clear statements and arguments, with which I wholly agree; but I wish to mention sundry points, the discussion of which cannot but help to elucidate the question, if opposing views be compared.

In his report proper, Mr. Tremontani mentions as one of the advantages of electric traction the possibility of using mixed traction, that is to say electric traction and steam traction conjointly.

In my opinion it is inadvisable to use steam locomotives to haul trains on an electrified line; all the more so as such a line, in order to be profitable, requires all the traffic it can get and cannot give up any part of this to the old steam locomotive, without seriously reducing its receipts. One serious objection against the use of electric traction is the high cost of the equipment necessary. Therefore it is not advisable to electrify lines with little traffic. Why then haul part of the traffic on an electrified line by a different method? Quite apart from the expense and complication of mixed traction, it seems to me that this reason alone is enough to condemn this system.

Yet if we find examples of lines where mixed traction is used — and the reporter mentions such — it seems to me that it is the electric system used which is the real cause, rather than the advantages of a system of mixed traction. The continuous current system used on the Milano-Varese line appears not to be very suitable for goods traffic, as steam locomotives continue to be used there for that purpose. Now I think that the electrification of a line must necessarily include the goods traffic, for by increasing the weight hauled, by electric traction, per kilometre of line, the cost of traction is materially reduced.

The reporter then states generally that a very great advantage of electric traction consists in the possibility of subdividing heavy trains into lighter and more numerous units.

In my opinion, this advantage only exists on one particular kind of railway, namely on urban and suburban lines. On lines with international traffic, with express trains, it would be difficult to have a frequent service of light trains.

It is, therefore, very necessary to distinguish between these two kinds of traffic, and to employ the system of traction most suitable in each individual case. Goods traffic however could never stand having its heavy trains divided into a number of lighter units. Consequently when the chief business of a line is its goods traffic, such line requires a system which will act as a perfect substitute for the steam traction of to-day, with its heavy trains.

These reasons are all in favour of having heavy trains hauled by locomotives. It is true that multiplying the number of trains increases the passenger traffic and the corresponding receipts. It will thus always be necessary to make a compromise between the requirements of economy (heavy trains) and those of a multiple service (frequent and light trains). Local conditions such as : amount of traffic, cost of energy, etc., will decide what system it is most advisable to adopt.

Further on in his report, the reporter again refers to this subject, when he considers the number of tractors to be used when a line is electrified. He gives the arguments of those in favour of locomotives, comparing them with the arguments in favour of multiple units and arrives at the conclusion " that the system of having trains hauled by an electric locomotive can be adopted in the case of goods trains and of trains with through carriages between distant points, on lines with gentle gradients where it is not necessary to obtain quick starting and to run at high speeds; whereas in all other cases the multiple unit system is to be preferred. "

In my opinion, the most suitable system is that which enables trains to be used, hauled in some suitable way, either by motor cars, or by locomotives. The three-phase Valteline line is the best example of this, as it has motor cars of 300 horse-power (296 British horse-power) and also locomotives of 1,800 horse-power (1,775 British horse-power).

The increased adhesive weight which results from the subdivision of the tractors does not necessarily affect the question, as long as the motive power necessary can be given by a single locomotive. In Europe the drawgear of the carriages hardly stands more than 10 tons (9·84 English tons.) Now, allowing 2 tons (1·97 English ton) for the working and the acceleration of the tractor, the latter should give 12 tons (11·81 English tons), measured at the tread of the wheels. With motors giving a uniform torque (continuous, polyphase) we can reckon on a coefficient of adhesion of 25 per cent. A force of 12 tons (11·81 English tons) thus requires an adhesive weight of 48 tons (47·24 English tons); certainly not an excessive amount. Therefore as long as it remains unnecessary to produce much greater tractive efforts, there is no need to adopt the multiple unit system in order to distribute the adhesive weight better.

#### **System to be adopted.**

The reporter then discusses the question of what system should be chosen, in the first place as regards the transmission, secondly as regards the distribution of the energy. As regards the former, he recommends unreservedly the use of high pressure alternating current, although very interesting results have been obtained with high pressure continuous current, on the Thury system.

In my opinion, the latter will never satisfy the conditions required for electric traction, and

that for well-known reasons. It is for this reason that I agree perfectly with the reporter on the use of high pressure alternators as generators at central stations

As regards distribution, the reporter enumerates the three following systems :

- 1° Continuous current;
- 2° Polyphase current;
- 3° Monophase current.

In order to compare these three systems, he discusses them separately, and then arrives at his conclusions. I do not agree with many of the arguments and conclusions of the reporter, as I propose to show below.

#### **Continuous current system.**

As soon as electric traction on a real railway is in question, continuous current cannot compete with high pressure alternating current, on account of the complicated system of transmission of energy. The advantages of the continuous current motor for purposes of traction can no longer make up for the disadvantages resulting from the necessity of having substations with rotating machinery, and of having the both expensive and dangerous third rail laid on the line. The latter is, moreover, being given up more and more, owing to its inherent disadvantages, by a large number of those formerly in favour of it; among them we may mention more especially Mr. George Westinghouse, who states quite plainly in a letter published in No. 25 of the *Electrical World and Engineer*, that overhead conductors are the line of the future, and that the third rail will be given up altogether.

Without wishing to discuss the disadvantages of that system more fully, I will confine myself to quoting the particulars contained in Mr. Paul-Dubois' report on the subject of the cost of equipping the line with a third rail.

According to him, the equipment of a kilometre of single track costs at least 25,000 francs (£1,600 per mile), and may easily reach 40,000 or 50,000 francs (£2,570 or £3,200 per mile), according to circumstances. The cost of a sub-station is 200 francs (£8) per kilowatt installed, with a minimum of 50 kilowatts per kilometre (80·5 kilowatts per mile); so this amounts to 10,000 francs per kilometre (£640 per mile). Thus the total, as a minimum, is 35,000 francs per kilometre (£2,250 per mile) of single track <sup>(1)</sup>. According to Mr. Paul-Dubois, the cost of the electric equipment of a line alone is one third or even half the total cost. On the other hand the cost of maintenance and of supervision of the sub-stations with rotating machinery increases the working expenses to such an extent that the latter, plus interest charges and sinking fund of capital invested, make it impossible to adopt this system.

It is thus not possible to say, with the reporter, that this " in the case of a line with much traffic and of new lines would not be a matter of much importance "; on the contrary, the heavier the traffic and the longer the line, the greater the importance of these disadvantages.

#### **Three-phase high pressure system.**

When considering this system, the reporter admits that it is less expensive in first cost and in working, as the rotary transformers and the supervision they require are eliminated; he does not discover any other argument in favour of this system but many disadvantages which, to some extent at least, are only apparent ones. It is true that this system has not yet been generally

---

(1) As opposed to 11,500 francs (£740 per mile), the cost on the Valteline.

adopted in America, the classical ground of electric traction, but I am convinced that as soon as our American colleagues recognize its advantages they will not hesitate to adopt it. It is for this reason that I have decided to bring these advantages to their notice as briefly as possible.

These advantages are firstly of a technical and secondly of an economical order; the latter affect the first cost as well as the working expenses.

As regards the former, the polyphase motor is, for equal power, the simplest and lightest. The ease with which it can be used direct for high pressure, as well as in a low pressure circuit, makes it eminently suitable for traction. The absence of a commutator, that source of risk and damage, makes it possible for the motors to stand a considerable overload, for there is no need to provide for good commutation.

Owing to the uniform torque of polyphase motors, the coefficient of adhesion nearly attains its theoretical value in practice. I may state that the results of measurements made on the Valteline show that it amounts to 25 per cent and sometimes even to 28 per cent; consequently, it is possible to have tractors which are light for the power they develop. One of the chief advantages of three-phase motors is that they automatically act as generators as soon as their speed exceeds that of synchronism by a few per cent. They return as current the energy produced by a train running down a gradient, whereas in each of the other systems this energy is converted into heat by the mechanical brakes.

This peculiarity of the motors can also be utilized, when stopping the train, to recover, electrically, part of the momentum of the train. By coupling up in cascade, the train can be braked electrically to the corresponding speed, thus recovering the kinetic energy due to the difference of these two speeds, less the losses in the motors and resistances.

This way of working makes the three-phase system particularly suitable for traffic where there are many stops and where the intervals between successive stations are short, particularly when the triple cascade arrangement is adopted, which make it possible to obtain four economic speeds with three motors.

Another advantage of the three-phase system, rarely considered but very important, consists in the "fly-wheel" effect of running trains on the central station. For if momentarily there is a considerable overload, for instance when two or more trains start simultaneously, the revolutions of the motor in the central station will decrease a given amount. As soon as this reduction exceeds 2 or 3 per cent, all the trains which are running can come into synchronism, or even into hypersynchronism. In the first case, they cease to consume energy; in the second, they return part of their kinetic energy to the line, thus relieving the central station to some extent. This fly-wheel effect continues until the speeds are once more in equilibrium. Experience on the Valteline shows this peculiarity of the three-phase system very clearly; it will be of even greater importance where steam is used at the generating stations.

The reporter then mentions as an objection to the three-phase system, the constant speed of the synchronous motors. He states that "a traction service must be such that the speed and the tractive effort may be able to vary within very wide limits." According to me, it is not the "traction service" which requires great variability in the speed. It seems on the contrary that uniform speed on a whole line makes it much easier to keep proper time. I think the reporter shares this opinion, for in the introduction to his report he mentions as an objection to the steam locomotive "the slowing which occurs on ascending gradients..., a train which running under full steam arrives at such a gradient, has its resistance per ton increased... the speed then becomes reduced."

On the other hand with electric motors, assumed to be shunt wound, this disadvantage does not

exist. Now as regards uniformity of speed, polyphase motors are very comparable with continuous current shunt wound motors. It, therefore, seems that the author agrees with us in considering that the uniform speed of polyphase motors is rather an advantage as regards the service.

I rather think the reporter raises this objection to constant speed from the point of view of economy, and of the excessive sudden demands which may result on the central station. I will consider the question of economy later on. As regards the bad effect at the central station of the sudden loads, I repeat that the "fly-wheel" effect of the whole system materially reduces sudden variations in the load at the central station.

Further on, the reporter states that arranging the motors in cascade in an unfavourable feature of the system. Now here I may at once state that the cascade arrangement is not an integral part of the system, and is only used where circumstances make this advisable. On lines with gentle gradients and stations far apart, where most of the running is at full speed, the cascade arrangement will not be adopted. But the nearer the stations are together, the greater the importance of the period of acceleration and of braking; and then it becomes advisable to have two or even three motors so coupled up. And then it can no longer be said that the tractor carries superfluous dead weight in the shape of unemployed motors, for the latter are working most of the time, and can become cool in the intervals. They can consequently be designed of a size suitable to the work, and then it is not correct to describe them as dead weight.

The result is not what the reporter states: increased weight and additional expenditure of energy. The weight of the locomotives of the more recent type on the Valteline line (motors arranged in cascade) is 62 tons (61 English tons); the maximum power given is 1,800 horsepower (1,775 British horse-power). So that the net weight per horse-power is 34.4 kilograms (76.9 lb. per British horse-power). The New York Central locomotive develops 2,400 horsepower, and weighs 86.5 tons (85.1 English tons); thus the weight per horse-power is 36 kilograms (80.5 lb. per British horse-power). This difference in favour of the three-phase locomotive would be still greater if the latter had been designed for a speed of 100 kilometres (62.1 miles), instead of one of 64 kilometres (39.8 miles) per hour.

It still remains for me to discuss the objection that it is impossible, with polyphase motors, to make up lost time.

Here only time lost during stops is in question, as any loss while running is made impossible *a priori* by the uniformity of the speed. Lost time is made up as follows: the ordinary time table is based on the normal speed, with motors arranged in cascade on steep ascents (if any) and with coasting, without current, down gradients. It is evident that if we do the whole distance at full speed, we can gain the more time the greater the distance. On down gradients the train can be accelerated by gravity, if it is necessary to increase the speed still further.

On lines with stations close together, time can also be made up by increasing the acceleration at starting and the retardation when stopping.

As regards first cost, the three-phase system is the best of the three. This is quite evident as regards continuous current; the use of high pressure and the absence of rotary transformers are the great points. For the purposes of comparison I may however mention the Valteline line, the equipment of which cost on the average 11,500 francs per kilometre (£740 per mile), substations included, as compared with the 35,000 francs per kilometre (£2,250 per mile) in the case of the continuous current line mentioned above.

If we compare its prime cost with that of the monophase system, we have in the first place to observe that the secondary conductors of the polyphase system will be more costly owing to the

second wire and its supports. But this greater cost is more than counterbalanced by savings in the rolling stock, in the central station and in the mains.

Monophase motors are much heavier and more expensive than polyphase motors of equal power. The regulating transformers which replace in the monophase system the rheostats are much heavier and cost more than the latter. Hence the weight of a tractor is considerably greater.

Monophase-current generators are more expensive than three-phase-current generators of the same power. In addition, when the former are used larger ones are necessary, as the monophase system has a lower efficiency.

Moreover, we know that a monophase line requires 33 per cent more copper, for the same pressure of energy transmitted and loss of pressure.

The superiority of the three-phase system over the other systems is especially marked as regards the consumption of energy, and consequently the working expenses.

According to the data given in the report to the eighth Italian Electrical Congress (see *Elettricità*, 1904, No. 44), accurate measurements were made on the Valteline line in order to determine the energy consumed by moving trains. Without going into the details of these measurements, I merely give the results :

1° A train having a gross weight of 120 tons (118 English tons), and hauled by a motor car, ran from Lecco to Colico (40 kilometres [24·9 miles]) with seven intermediate stops, the maximum speed being 64 kilometres (39·8 miles) per hour. The consumption was 31 watt-hours per ton-kilometre (50·7 watt-hours per English ton-mile), measured on the trolley.

As opposed to this, the specific consumption on the monophase line Schenectady-Ballston of the General Electric Company in America amounts to 86 volt-ampere-hours (see *Street Railway Journal*, No. 9, August 27, 1904).

The consumption on the Stubai-Bahn in Austria, equipped by the *Union Électrique Cie*, on the monophase system, amounts to 70 watt-hours per ton-kilometre (114·5 watt-hours per English ton-mile).

It is true that these results are not strictly comparable, for the distances between stations, the gradients and the speeds differ. However, a comparison can be made by taking the figures given by polyphase motors during trials. Thus if we calculate the specific consumption on the Stubai-Bahn, for the three-phase system, we get as result 30 watt-hours per ton-kilometre (49 watt-hours per English ton-mile). The causes of this great difference between the two systems is that energy is recovered, with the three-phase system, on down grades.

2° The energy required for hauling a ton on the flat at 64 kilometres (39·8 miles) per hour was found to be between 12·5 and 13·5 watt-hours (between 12·7 and 13·7 watt-hours per English ton). The corresponding figures on the Milan-Porto-Ceresio line (with third rail) is, according to the reporter, 30 watt-hours (30·5 watt-hours per English ton). It is true that the train was then running at 90 kilometres (56 miles) per hour, but a difference of 40 per cent in the speed does not account for a difference of 130 per cent in the consumption per ton-kilometre, unless the worse efficiency of the continuous current system also comes into play.

The average consumption at Morbegno central station, on the Valteline line, amounts to 44 watt-hours per ton-kilometre (71·9 watt-hours per English ton-mile). But this figure includes secondary applications, such as the energy for lighting and heating the trains and for lighting the stations, and the energy used in the repairing workshops at Lecco. The result of special measurements taken in order to determine the efficiency of the energy transmission from the

switchboard of the central station to the trolley, made on April 24, 1904, was 87·5 per cent. Knowing that the specific consumption of the line is 31 watt-hours (50·7 watt-hours per English ton-mile) (all losses on up-gradients, during acceleration, etc., included), and taking this efficiency into consideration, it follows that the secondary applications require 9 watt-hours per ton-kilometre.

As these figures, obtained in practice, are much better than those obtained on the Milano-Porto-Ceresio line, it is incorrect to speak of the bad efficiency of the three-phase system and the bad regulation of the polyphase asynchronous motors.

Even in the case of lines where stops are frequent, is the three-phase system superior to the other systems, as regards economy, if the triple cascade arrangement is adopted; for calculations made in connection with different projects for electrifying metropolitan lines show that the energy recorded during braking, with the cascade arrangement, exceeds by 50 to 100 per cent the energy lost in the rheostats during starting.

The reporter considers that the ideal system of electric traction is that the motor car by itself should constitute the train. Even if that be so from the point of view purely of electric traction, it certainly is not the same as regards operating important lines with international traffic, on which heavy and fast trains have to run according to a definite timetable. The ideal system is therefore that which can replace, without difficulty, the steam locomotive of to-day, so that light trains may also be run.

What I have stated, I think proves that the three phase system has manifold advantages, which however have not as yet succeeded in giving it that position in electric traction which it merits. This is due to the one definite disadvantage the system possesses: that there must be two overhead conductors. But practice has shown that the true solution of this problem is merely a question of proper construction. The experience of nearly three years on the Valteline line has proved that no disadvantage, no disturbance in the service, has resulted from the double line.

The reporter, in the continuation of his report, considers the monophasic system, of which he enumerates the chief advantages, and then gives a summary, with which I entirely agree as far as the general features are concerned. But when he considers the electric supply system to be adopted, our opinions no longer agree.

I propose to amend the proposed conclusions as follows:

1° The continuous current system, for reasons of economy and safety, cannot compete with any other high pressure system, in cases where traction on long railways is concerned. It should therefore be given up;

2° The three-phase high pressure system is particularly suitable for heavy traction, both on trunk lines as well as on metropolitan lines; at the same time it makes it possible to run light trains on the same lines. Its advantages from the technical, the operating and the economic points of view, render it superior to all other systems. Its only disadvantage, of requiring a double conductor, is more than counterbalanced by its other advantages. It has been proved in practice under difficult conditions;

3° The single phase system has not yet been tried for heavy traction. On lines so equipped, where results have been obtained, the traffic is more of the tramway kind, with light train-units. The energy consumed is distinctly unfavourable. It may be that the saving to be effected in first cost will result in its application on secondary lines; but it is advisable to await what results the application of this system will give in practice in the traction of heavy trains.

---

3<sup>rd</sup> SECTION. — WORKING.

---

[ 628 .253 & 628 .254 ]      QUESTION IX.

---

LIGHTING, HEATING AND VENTILATION OF TRAINS

(2<sup>nd</sup> AND 3<sup>rd</sup> SECTIONS JOINTLY.)

---

*Improvements made in the lighting, the heating and the ventilation  
of trains.*

*Reporters :*

*America.* — Mr. C. B. DUDLEY, chemist, Pennsylvania Railroad.

*Other countries.* — Mr. Cajetan BANOVITS, conseiller ministériel, directeur du matériel et de la traction des chemins de fer de l'État hongrois.

## QUESTION IX.

---

## CONTENTS

---

	Pages.
Sectional discussion . . . . .	1451
Report of the 2 <sup>nd</sup> and 3 <sup>rd</sup> sections meeting jointly . . . . .	1458
Discussion at the general meeting . . . . .	1458
Conclusions . . . . .	1467

### PRELIMINARY DOCUMENTS.

Report No. 1 (America), by C. B. DUDLEY. (See the *Bulletin* of January, 1905, p. 519.)

Report No. 2 (other countries), by Cajetan BANOVITS. (See the *Bulletin* of April, 1905, p. 1585.)

Vide also the separate issues (in red cover) Nos. 26 and 45.

---

# SECTIONAL DISCUSSION

---

(2<sup>nd</sup> AND 3<sup>rd</sup> SECTIONS JOINTLY.)

---

Meeting held on May 8, 1905 (morning).

---

MR. ED. SAUVAGE, PRESIDENT OF THE 2<sup>nd</sup> SECTION, IN THE CHAIR.

**The President.** (In French.) — The business before us is to discuss the reports of Messrs. C. B. Dudley and Banovits on the lighting, heating and ventilation of trains.

It will probably suit the meeting best if we taken up each of the three subjects separately. (*Agreed.*)

The following are the conclusions proposed by Mr. Banovits, who is unfortunately not here :

In consequence of the continual improvements and advances made in the lighting, heating and ventilation of railway carriages, the general average level of these appliances has steadily improved during the last few years.

Nevertheless, appliances are still largely used, which satisfy the reasonable requirements of passengers only very inadequately or very moderately.

The better and more improved appliances may be divided into two groups; the one comprises the appliances which owing to their efficiency can satisfy all requirements, however exacting, but which require separate attention, and can consequently only be used with advantage in special cases, and not where there is much traffic; the other comprises the appliances which can satisfy all modern requirements, and owing to the simplicity of their manipulation are suitable for the best trains, and allow a large amount of traffic to be dealt with readily and expeditiously. It is self-evident that in such appliances also further improvements are still to be made.

To the second group, which is most suitable for the improvement of deficient appliances, belong :

a) As regards lighting : gas, mixed gas and electric lighting; the last, owing to its many advantages, is worthy of special attention and its use should be extended as much as possible;

b) As regards heating : the various systems of steam heating, the steam and the condensed water conduction being kept as separate as possible; or even separate piping being provided for carrying off the condensed water;

c) As regards ventilation : the roof ventilators, with their action increased as much as possible by combining them with pipe ventilators; in this connection, it should also be noted that it is desirable to supplement the ventilation by providing for the supply of fresh air in addition to removing the foul air.

Finally, it must be emphasized that for these reasons also special importance must be attached to the proper and suitable design of the carriages, as not only is the proper working of the appliances mentioned above better ensured, and consequently the legitimate demands of passengers realized, by this means, but the safety of the traffic is also increased.

I now call upon Mr. Dudley to give us a summary of his report.

**Mr. C. B. Dudley, reporter for America.** — It is hardly necessary, I think, to say much by word of mouth on these subjects, as the whole report is in print in both French and English, and those who are interested will undoubtedly have an opportunity to read the same. In order, however, to bring up the matter in a more concentrated form, it may perhaps be desirable to say a few words with regard to the various points which are covered by the report.

As regards lighting, it must first be noted that since the last meeting of the Congress, the subject has advanced and that candles and oil lamps are disappearing. Though candles and lanterns still survive, they are only used for extraordinary lighting. As for oil gas, its use seems to be extending much, whereas that of coal gas appears to be decreasing.

I would draw attention to the installation carried out on one of the Pennsylvania's cars, exhibited in 19<sup>th</sup> street, as being worth inspection. At present we have in the United States some 25,000 or 26,000 cars lighted with oil gas and this method of lighting tends to extend day by day.

We are now likewise making experiments on a large scale with electric lighting in five different ways :

1° By the use of movable accumulators which are charged at fixed points and carried in the cars;

2° By the use of accumulators fixed under the cars and recharged while the cars are standing idle;

3° By the use of dynamos operated by the motion of the car axle;

4° By the use of a dynamo situated in the baggage car;

5° By means of a steam turbine driving a dynamo situated on the locomotive. This last method has been tested only to a limited extent. As all these experiments have not been carried out for a sufficiently long time, I do not think we can yet arrive at any definite decision about the various methods.

Besides gas and electricity, acetylene has been tried to some extent. It is being used for instance by the Adams & Westlake Company of Chicago.

This method of lighting has been tried in three different ways :

1° With generators situated in the cars themselves;

- 2° With receivers holding compressed acetylene; and
- 3° With acetylene dissolved in acetone, in cylinders containing some absorbent material.

The last method seems likely to become most common.

As regards prime cost and consumption, not much can be said, and I hardly think we can as yet arrive at figures concerning the cost of upkeep.

As to car-heating, the best method seems to be to use steam from the locomotive and the Baker system makes it possible to use either steam or coal as one chooses. The proper diameter for the pipes and the arrangements of the connections are the most delicate points in the equipment. Under this head, I call attention to the three methods of coupling shown at the exhibition, now open, which render it possible to connect automatically and simultaneously the air and steam pipes and the alarm signal.

Lastly coming to ventilation, I must say this is an important matter; a method to be good ought to work as well in summer as in winter and it ought to be suitably combined with a system of heating. Careful investigations on this subject have been made by the Pennsylvania Railroad Company.

For further details I may refer to page 11 *and seq.* of my report <sup>(1)</sup>. With our system, the air is taken from outside, down under the flooring of the cars through hoods and down-takes situated diagonally at each end. The air comes up through the floor to the heater boxes where it is heated by radiators and then flows into the body of the car where it spreads and passes out through ventilators in the roof. Investigations were undertaken by the Pennsylvania Railroad Company as to how much fresh air comes into an American car per hour and I estimate the quantity at about 60,000 cubic feet. (*Applause.*)

**The President.** (In French.) — We will now begin to discuss the two reports but we will attack first the subject of lighting.

**Mr. Wickersheimer,** French State Railway. (In French.) — I should like to be provided with a few details about the use of acetylene in lighting passenger carriages.

When not compressed, acetylene gas is not at all dangerous. I have had no experience of it on our railways, but for at least four years I have seen it in use at a country house where I reside. I know the gas is very easy to manage and is not at all dangerous provided that no explosive mixture is manufactured artificially.

According to Mr. Banovits' report, acetylene gas is used at a pressure of 18 to 20 centimetres ( $7 \frac{1}{16}$  to  $7 \frac{7}{8}$  inches) of water; this is an exceedingly low pressure, for there is not the very slightest danger even at a pressure of one or two metres (3 ft.  $3 \frac{3}{8}$  in. or 6 ft.  $6 \frac{3}{4}$  in.).

I see in Mr. Dudley's report, that the one difficulty not yet overcome, is that in the winter

---

<sup>(1)</sup> Vide *Bulletin of the Railway Congress*, No. 1, January, 1905, p. 327.

season, the car must always be kept warm, in order to prevent the freezing of the water, and consequently the system is apparently only applicable to those cars, which have an independent source of heat, like the Baker heater system.

Experience has shown that when a certain quantity of alcohol is added, freezing does not take place; so then the use of acetylene is as convenient and easy in winter as in summer.

The question I wish to ask is therefore the following : Has any engineer who has used acetylene tried any other method of preventing its freezing?

**Mr. Max Toltz**, Manistee & Grand Rapids Railroad, United States. — **Mr. C. B. Dudley** was kind enough in his paper to mention a system which a friend of mine, **Mr. Lipschutz**, and myself developed. In a general way, I will give the details of this system. In 1899, the speaker was requested by **Mr. James J. Hill**, president of the Great Northern Railway, to improve the lighting of cars on that railway and it was proposed to use acetylene in some form. For that reason, tests had to be made, and as it was proposed to use this gas compressed, neat, a study had to be made of calcium carbide and acetylene. I will not take up your time by going into details, but will only mention that the dangerous mixtures of acetylene gas are the following. Explosion will start when 3 per cent of this gas is mixed with 97 per cent of air; it will be at its maximum when the mixture is 11 per cent gas and 89 per cent air; and it will stop when proportions are 24 per cent gas to 76 per cent of air.

Some twelve years ago the Pintsch Company in Germany, made a series of experiments and tests with compressed acetylene. They established the fact that this gas, compressed at or over 2 atmospheres, will dissociate when heated to 1,432° Fahr., which physical change is imparted to the whole body of gas, resulting in an explosion of a serious character. It was further found that no shock or blow given to a tank in which compressed acetylene is charged will create an explosion of said gas.

Following on this line, a series of tests were laid out to establish the safety devices employed in the present system.

*First test.* — A tank filled with acetylene compressed to 10 atmospheres was surrounded by a slow fire made of wood. When the heat had risen to about 1,000° Fahr., the tank was pierced with a rifle bullet to establish the fact that such a blow would not create an explosion. The gas simply escaped through the holes made by the bullet and was ignited by the fire and was consumed in about two minutes and a quarter.

*Second test.* — A tank charged with acetylene compressed to 10 atmospheres was placed under a hammer with which freight car wheels are tested. The weight of the hammer was 1,200 pounds and the fall about 8 feet. The tank was perfectly crushed, but no explosion took place and wherever the seams of the tank opened, gas merely escaped.

*Third test* — To a tank charged with acetylene compressed to 10 atmospheres, a

gas pipe  $1\frac{1}{2}$  inch in diameter and 50 feet long was attached. The end of the pipe was plugged and a fire started a few feet from this end. As the temperature finally reached the danger point, the gas in the pipe, at the application of the heat, dissociated and was accompanied by a disastrous explosion that was imparted to the tank. This last is due primarily to the high velocity of the explosion wave in the body of compressed acetylene and to the very rapid communication of the dissociative action to all parts of the body of compressed acetylene.

*Fourth test.* — To a tank having fusible seams and charged with compressed acetylene to 10 atmospheres, a pipe consisting of block tin and having the same length as the one in test No. 3 was connected. The tin employed has a fusing point of less than 500° Fahr. The pipe at the end was plugged and a fire was built near that end and as soon as the heat was raised to the fusing point of the metal, the pipe opened and the gas simply escaped, being ignited by the surrounding fire. It took about two minutes to consume all the gas which was in the tank.

*Fifth test.* — Around a tank with fusible seams and fusible plugs, charged with acetylene compressed to 12 atmospheres, a big fire was built. After several minutes the heat simply opened the fusible seams and plugs, allowing the gas to escape, but no explosion took place. There were fourteen plugs in the tank and all seams were soft soldered. The metal used for the plugs and for the soldering of the seams was tested to its fusing point, which was a little over 450° Fahr. In this test it took less than thirty seconds to consume all the gas which was in the tank after the plugs and seams had melted.

From the results of these tests, the system of lighting cars with compressed acetylene, but with the special view of using the present Pintsch equipment under and in the cars, was established. The main object has been to provide means whereby acetylene gas under high pressure can be carried within a suitable receptacle in or under a passenger coach with absolute safety. Therefore, the reservoir or tank is constructed with seams which are soft soldered and having fusible plugs in the shell, that will fuse at a temperature of 500° Fahr. or less and permit the contents of the tank to escape and prevent an explosion of the gases therein should the tank be subjected to an intense heat, as by the burning of the car or train.

To determine the value of the fusible plugs, made out of different material, further tests were made by the Canadian Pacific, and three different fusible plugs were used and in every case the tests were satisfactory. In other words, the plugs fused away below the danger point. Another safety appliance in the system is the fact that the high pressure pipes under the car which lead from the tank to the regulator or reducing valve are made of tin which will fuse at or below 500° Fahr. The car equipment is the same as used in the Pintsch system.

The Great Northern Railway is making experiments now with an iron pipe for the high pressure pipe, but they inserted a safety device between the tank and the regulator, which has the purpose of providing means whereby dissociation, if it

occurs in the high pressure pipes, may be localized and stopped or broken up, thus allowing time for fresh gas to enter the device from the tank and stop the progress of action, whereby the effect of the explosion in the pipes is minimized and disaster to the main body of the gas prevented.

After the gas has passed the regulator, it is delivered to the pipes in the car at a pressure of 2·5 to 3 inches water pressure. The Pintsch lamp should be remodelled, inasmuch as the pipe which supplies the gas to the burners is centrally located in the lamp and is surrounded by the flames. This arrangement would unduly heat the acetylene gas and polymerize it.

The globes, instead of being clear glass, are made of opal, milk white glass, which diffuses the light more, although a certain amount of the light is cut off. The burners used in the lamps are high grade, and are manufactured by Von Schwartz, in Germany.

The efficiencies of the burners are as follows :

BURNERS.	CONSUMING PER HOUR.	PRESSURE.	CANDLE-POWER.	EFFICIENCY.
1 foot	0·97 cubic foot.	2·7 inches.	41·6	86 per cent.
$\frac{3}{4}$ —	0·73 —	2·7 —	31·0	77 —
$\frac{5}{8}$ —	0·60 —	2·7 —	24·0	75 —
$\frac{1}{2}$ —	0·48 —	2·7 —	16 0	66 —
$\frac{3}{8}$ —	0·33 —	2·7 —	8·0	50 —

Experiments with mantels have also been conducted, but so far they have not been a success.

The success of any acetylene gas system depends to a great extent upon the means employed for the generation, drying, storage and compression of the gas preparatory to use. For that reason, and to generate the gas at low temperature, a generator is used that drops a small quantity of carbide into a big volume of water. After the gas is generated, it passes through a water seal where a fine spray of water is made to play over the gas, for the purpose of removing some of the sulphurated hydrogen. From there it is taken through a filter of wood cardings and wool felt in order that it may be cleaned from all lime particles. It finally is compressed in a three-stage compressor, the pressure at discharge pipe of each cylinder being as follows :

Low pressure.	30 lb.
Intermediate .	80 —
Final pressure .	240 —

Assuming that no cooling effect occurred during the period of compression, and the gas was cooled to normal temperature between the stage, only, the theoretical temperature would be :

In the low pressure cylinder . . . . .	285° Fahr.
In the intermediate cylinder . . . . .	186° —
Final discharge . . . . .	234° —

By several modifications of the original design of the compressors, the manufacturers finally succeeded in delivering the gas at the following observed temperatures, viz. :

In the low pressure cylinder . . . . .	150° Fahr.
In the intermediate cylinder . . . . .	111° —
Final discharge . . . . .	120° —

The difference between the latter and the adiabatic temperatures given above was caused by the thorough cooling arrangement provided in the compressor.

The Great Northern Railway has up to date 155 cars equiped. They have only one plant, located at St. Paul, but their cars run from St. Paul to Seattle, a distance of 1,800 miles, and upon returning to St. Paul they still have enough of the acetylene gas left for a trip of 1,800 miles

The cost of the gas in 1902 was \$10.45 per 1,000 cubic feet. In one month, March, 1902, the cost of the gas was \$7.66 per 1,000 cubic feet of gas. This was due to the fact that a very cheap second grade carbide could be had at that time.

The cost of lighting per car per night during the year 1904 at the rate of \$9.94 per 1,000 cubic feet, is as follows :

KIND OF CARS.	Numbers of cars.	Numbers of trains.	Nights out.	Cubic feet gas used.	Average consumption per night.	Average candle-power per car.	COST PER NIGHT PER CAR. 1 CUBIC FOOT ACETYLENE EQUALS 4 CUBIC FEET OIL GAS.		
							Acetylene per 1,000 cubic feet. \$9.94.	Oil gas per 1,000 cubic feet.	
								\$5.00.	\$3.00.
Coaches . . . . .	354	1 and 2	4 1/2	352	85	...	\$ 0.84 1/2	\$ 1.70	\$ 1.02
	357	3 and 4	6	407	78	342	0.77 1/2	1.56	0.94
Dining . . . . .	707	1 and 2	4 1/2	446	99	...	0.98 1/2	1.98	1.19
	713	3 and 4	6	425	71	993	0.70 1/2	1.42	0.85
Sleeping . . . . .	950	1 and 2	4 1/2	542	124	748	1.23 1/4	2.48	1.49
Tourist . . . . .	834	1 and 2	4 1/2	297	66	498	0.65 1/2	1.32	0.79
Library . . . . .	752	1 and 2	4 1/2	446	99	716	0.98 1/2	1.98	1.19
Baggage and ex. . . . .	586	1 and 2	4 1/2	255	57	...	0.56 1/2	1.14	0.68
	572	3 and 4	6	298	50	248	0.48 1/2	1.00	0.60

On the Canadian Pacific, they have to date equipped 369 cars. The cost of the gas during the first three months of this year is \$9.02 per 1,000 cubic feet, and the average cost per car per night consuming 94.4 cubic feet per night is 86 cents. The cost of a plant having a capacity of 2,000 cubic feet per hour, is \$15,000 including the building. The cost of a plant having a capacity of 1,000 cubic feet per hour, including the building, is \$9,000.

While acetylene possesses five times the illuminating power, volume for volume, of oil gas, this relation does not hold good for the heat units. The heating ability of acetylene is to that of oil gas, volume for volume, as 1,683 is to 1,273. The candle power of oil gas drops from 60 to 40 candle-power when the same is compressed to 10 atmospheres and the pressure is limited to this figure, not by considerations of safety or by the apparatus, but by the prohibitive loss in candle-power which the gas undergoes if the pressure is exceeded beyond that point. Acetylene may be compressed to 600 pounds per square inch without undergoing any loss in candle-power.

The information given by Mr. Dudley in his report that only two roads in America are using neat acetylene compressed gas is correct, but this is due to the fact that the Canadian Pacific Railway Company owned the Canadian patent rights, and the Great Northern Railway Company are operating under a license given them by the patentees, the Pintsch Company controlling the patents in the United States. In regard to the working of the system on the Great Northern, I will say that it has been in vogue since 1899. No accidents have occurred, except two cases. Cylinders have exploded under conditions that should not be charged against the system. At that time the tanks were not prepared with fusible plugs, but had fusible seams only. In one case a whole train was run over a bridge which was burning, and, of course, the cylinder gave way. There was no damage done, except that one side of one car was charred. In another case a car cleaner was thawing out a steam trap and with his torch he came too near to the high pressure pipe, which, of course, fused, and in doing so he turned the high pressure against the tank, and as this tank had no fusible plugs it exploded. There was no damage done, except that the car cleaner was thrown about 50 feet from the car, without being seriously hurt.

**Mr. Wickersheimer.** (In French.) — Could you answer the question, I asked just now? Has anybody tried a mixture of alcohol and water in the generator to obviate freezing in winter?

**Mr. Max Toltz.** — Alcohol and water has not been used in America — we have used glycerine on top of the water.

**Mr. W. E. Fowler,** Canadian Pacific Railway. — Mr. President and gentlemen, it perhaps might not be inappropriate following the detailed statement of the inventor of this system of acetylene lighting which is now being discussed, to give you a statement from the standpoint of the man who is using it every day.

The Canadian Pacific Railway Company for several years before my connection

with it had been testing a number of different lighting systems — acetylene lighting under two methods and electric lighting systems of three kinds were experimented with. About two years ago, the system described by Mr. Toltz proved so attractive to the road that they decided to make extensive use of it. Mr. Toltz has described the system in detail very clearly, but I want to follow Mr. Toltz' statement with one of my own, to the effect that since the Canadian Pacific Railway has been using the system — we now have it installed on 369 cars — we have not had a single accident connected with it.

I do not think Mr. Toltz referred to the test that the Canadian Pacific made about two years ago, of three of the receivers or tanks which he has described, with a view of determining, from their own experiments (regardless of the statements made by the inventor), whether or not these tanks could be exploded by fire. We prepared these three tanks with plugs of various fusible materials, and prepared a tank or enclosure of old rails, suspended the tanks successively in this enclosure on chains — having first laid a quantity of dry wood under them — and to prevent any injury in case the tanks should explode, we covered them up with the rails. We started the wood fire, having saturated the wood with kerosene, and retired a short distance away. Within a period of I think two minutes, several of the fusible plugs in each of these tanks melted out, the gas was released and they took fire, of course, but there were no explosive features whatever. After the first tank was tested, we were not so careful to retreat a respectable distance, and we remained very close to the tanks being tested in the two last cases, each of which, however, gave the same satisfactory results.

Mr. Toltz referred to the use of opalescent globes for the lighting. It is true that in our sleeping cars we use that character of globes, but on account of the great absorption of light by that medium, we have largely dispensed with its use, and in our second class cars, our baggage cars and mail cars, we have gone back to the use of the clear globe, with the result that we are reducing the cost of lighting the cars very materially.

The cost of the production of gas has been referred to by Mr. Toltz as being in the neighbourhood of \$9.94. You, gentlemen, will understand that as the quantity delivered by each one of these plants is increased, the cost of production will be correspondingly decreased, and as the Canadian Pacific Company is adding to its equipment all the time we are almost every month reducing the cost. As far as the recommendations of the light itself is concerned, perhaps Mr. Toltz has already given you all that is necessary, but I want to say that we find it very satisfactory — it is a bright, clear, white light, easily handled. We are not troubled with law suits by passengers on account of oil dripping on their clothes; there are no carpets to renew on account of the oil dropping down on them; and we have no expense for damages on account of lamps falling from their sockets and injuring passengers, which has happened occasionally with the oil lamp. In short, I may say that it is generally a very satisfactory equipment.

A test of the comparative cost of lighting by oil lamps and lighting by the Toltz-Lipschutz acetylene gas system has been going on for some little time. I am sorry that I have not the figures with me to give them to you accurately, but I can say in a general way, that we are to-day getting three times the candle-power at about the same cost as we formerly got from the oil lamp; and in order to make that statement of more value I wish to say that the Canadian Pacific passenger cars, even when lighted by oil lamps, were what might be called profusely lighted, and that is true of them to-day. The number of lamps in each car were considered by practical men as being entirely too many, and those who have had experience with oil lamps know also that the oil lamp in the warm nights of summer is a very undesirable feature. The acetylene gas lighting is much cooler than any other system I know of, and has entirely removed this objectionable feature which is inherent in the oil lamp. We found that our sleeping car, patrons very soon became acquainted with that fact. In the changeable days of the fall and spring months, in the evening, as soon as the oil lamps were lighted, the car was heated up almost beyond endurance; but since we have used the acetylene gas lamp we get a much more brilliant light with a cool and comfortable car.

I shall be glad, if I can, to give any further information to the delegates present, but I do not think of anything which I can say in recommendation of the system, more than I have said, which we have found so successful.

**Mr. Brisse, French Eastern Railway.** (In French.) — Does not charging the receivers and the production of the gas lead to leakages which are objectionable to passengers?

**Mr. W. E. Fowler.** — I have heard no objection at all to the charging of cars in our stations, although we now charge cars in three of our principal stations on the lines. Indeed, there can hardly be any objection, for by the use of the Pintsch system which locks the gas up in the transfer hose — the hose which transfers the gas from the pipe line to the receiver on the car —, there should not be any escape of gas. If there is at any time, it can only be from some defect in the valve. I presume the gentlemen here are familiar with the Pintsch system of transferring gas from the pipe lines to the car, and this acetylene gas system that has been described by Mr. Toltz, which we are using, uses the Pintsch apparatus practically all the way through. Practically, the only changes in the Pintsch system are the safety features which he has described, that is, the plugs in the tanks and the fusible pipe connected with the regulator, the change in the burner and a method of bringing the pipe down through the lamp. There is no smell noticeable as far as I can determine. I may say that I think the acetylene gas system will compare very favourably with any record made by the oil gas system.

**Mr. R. Fane-de-Salis, North Staffordshire Railway, Great Britain.** — I should like to mention a method of generating acetylene gas with which possibly some of you

gentlemen here may have had more practical acquaintance, and which gets over, or promises to get over, the difficulty both of freezing and of the fouling of pipes which takes place from the residual products when water is used. That is what is called the dry system of acetylene gas. The gas is generated by the use of bicarbonate of soda mixed with calcium carbide, instead of using water. No water is used at all. I do not think that system has been tried in a train as yet, but it has been in a station. We, on my line, have lighted one station for the last six months with this dry system, and with very satisfactory results. We have had no trouble with frost, and our engineer reports that there is no trouble with the pipe fouling. I have not the exact figures of cost, but to fit up a station for twenty lights cost us £130, and I believe the cost of running is working out at a price equal to coal gas at 3s. 6d. a 1,000 cubic feet, including interest on the initial cost of the plant. The Great Western Railway have also tried that at one station. Possibly if any of their representatives are here they could give information about it; but I believe it is answering very well. The company that has brought out this system is I think going to try it for train lighting. There seems no reason, as it answers in the station, why it should not answer in a train.

**Mr. Verlant**, Paris-Lyons-Mediterranean Railways. (In French.) — The Paris-Lyons-Mediterranean uses about 25,000 gas lamps to light its carriages. Formerly these lamps only burned rich gas distilled from bog-head. Five years ago, the Company decided to improve its lighting by mixing 20 to 25 per cent of acetylene with this gas. This admixture has proved highly satisfactory. At first, there were a few difficulties in purifying the acetylene which always contained a certain amount of phosphorus and consequently spoilt the reflectors. But we have contrived to do away with this objection by purifying it more thoroughly.

I must confess that there are other complications due to the necessity of having two sets of works, one for producing gas and the other for the production of acetylene.

In view of the results obtained by the Eastern Company with incandescent mantles, the Paris-Lyons-Mediterranean was likewise led to try this method. It was thought that it might be preferable to do our lighting with rich gas, so as to avoid the complication of having two sets of works and to get the Welsbach mantles to last longer. For after a few days these get spoilt if acetylene gas, not completely purified, is used. It was for these reasons that my company decided to give up acetylene with incandescent mantles and to resort to bog-head gas with Welsbach mantles.

**Mr. Brisse**. (In French.) — I think I can support what Mr. Verlant has just said.

A few months ago, the French Eastern Company decided to add incandescent mantles to all its oil gas burners. After a series of trials, chiefly concerning the burners and their proper height in the compartments, concerning the installation of the globes and lastly, the most important point, on the kind of supports provided

for the mantles and on the life of the latter, the Eastern Company came to the conclusion that a mantle on an upright burner might under ordinary condition last an average of forty days or more. At the same time as the upright burner, we tried the inverted burner which is being used on a few of the Western Company's suburban lines and which, as regards the quality of light, offers considerable advantages. It is to be noted however, that with this inverted burner the mantle lasts less long than with the upright burner. The inverted burner possesses, besides, some fairly serious disadvantages. It is rather difficult to keep the light in the cars sufficiently brilliant when the mantle gets partly destroyed. With the upright burner, on the contrary, this disadvantage does not exist. When a mantle becomes detached from its support, it is held up in a little cup which keeps it above the burner and this makes it possible to keep up a bright enough light in the compartments.

I may further say that the use of upright incandescent burners is more economical than using oil gas burners and gives a few more brilliant light.

**Mr. Van Loenen-Martinet**, Dutch Railways. — Mr. President, I can give you some information on this question of lighting passenger carriages that may perhaps be of some interest to the gentlemen here. The company with which I am connected has been using for some eight years the Pintsch oil gas lighting, mixing that gas with acetylene in the proportion of 15 per cent of acetylene to 85 per cent of oil gas. Some three years ago, our gas plant had come to its full capacity, and then we had to choose between either building a supplemental plant, which would of course make the production of gas per unit much higher, or looking out for another system of lighting. At that moment, we did not consider at all the question of lighting by pure acetylene gas, because that system was considered in our country, and I dare say in Germany also, as altogether dangerous. We have on our lines two acetylene gas plants for lighting stations, and in one of these plants, we had two severe explosions, and the most disagreeable thing was that the real cause of those explosions could not be found out. I know also that in Germany, at Strasburg, there has been a very severe explosion, the consequence of which was that the railroads were obliged by the government to build a new plant some miles out of the town. They did not like to do that, and took up oil gas lighting with Welsbach lamps. So we three years ago did not like to take up acetylene lighting, and we began with the Stone electric light. We chose that system because at that moment we considered the Stone electric lighting system as the only one adopted by several railroads in a general way. Thus far we have fitted up some 10 per cent of our carriages with the Stone system, and I can say that we are very well satisfied with it. As for comparative cost, that is always a very difficult thing. You can reach whatever figure you like in carriage lighting. It depends on the hours of burning and all that; but in a general way, the most positive fact we can state is as to the yearly cost per carriage, taken all in all. Now, if we do that, I can say that

including the maintenance of the batteries, the Stone electric light system is perhaps 20 per cent more expensive than our mixed oil gas lighting. I can add perhaps that the Stone system is applied to carriages with 250 to 260 candle-power.

**Mr. Sarre**, German Government. (In German.) — As I was not able to prepare a complete statement for this purpose, I will say only a few words improviso. On the railways of Alsace-Lorraine preferably mixed gas, consisting of oil gas and acetylene gas, is used for lighting passenger carriages.

**Mr. Van Loenen-Martinet** referred to an explosion that happened a few years ago in one of our mixed gas works. That accident was rather a serious one; unfortunately one man was killed by it. It was the more alarming, as in the whole department everything had been revised a little while before the explosion, and no neglect of duties could be stated. This accident induced the administration of the railways of Alsace-Lorraine to try on a greater scale incandescent gas lamps, in order to make unnecessary the production of acetylene gas. In the beginning, two burners were put in each lamp, so that if one incandescent mantle should fail at any time, the other is still intact. In these burners the gas is admitted from below. The experiments had quite a satisfactory result.

Just now we have begun trying another arrangement similar to that of which **Mr. Brisse** of the Eastern Railways of France has spoken, that is to say, the incandescent gas lamp with an inverted mantle of the Auer von Welsbach-system, and this has so far given very good results in general, and in an economical way. It has been arranged in the workshops of **Mr. Pintsch** at Fürstenwalde near Berlin, who is himself the owner of the patent. An absolute and definitive judgment cannot be given at present as to the use of this system; but on account of the results already obtained, I propose a change be made in conclusion A of our report, by inserting after the words "mixed gas" the words "incandescent gas" and omitting the last clause, reading as follows: "the last (electric lighting), owing to its many advantages, is worthy of special attention and its use should be extended as much as possible." I guess that is saying too much about the overwhelming advantages of electric lighting, which are not entirely established thus far. Therefore I propose that change.

**Mr. William Clow**, Great Central Railway, Great Britain. — **Mr. President**, I have been connected with the lighting of trains for the last twenty-seven years, and have had nine years experience in lighting by electricity from dynamos fitted to an axle of each carriage, and I have no hesitation in saying that so far as my experience goes in England, electric lighting gives more general satisfaction than any other system. On the Great Central Railway of England, we have 1,631 cars, about 50 per cent of which are fitted with electric light, 40 per cent with gas and 10 per cent with oil. All the new stock will be electrically lighted and the use of gas and oil will be got rid of as quickly as possible. The proper lighting equipment for an up-to-date railway is, in my opinion, electricity. (*Applause.*)

**Mr. H. Tylston Hodgson**, Midland Railway, Great Britain. — I would just make two observations with reference to the increase of light in railway carriages. We find on the Midland Railway, a constant demand for more and more light, and therefore we find it very hard to compare the expense of the past with the expense of the present. I should very much like to know whether that is the experience generally. Whether it is the closer acquaintance that people have with electric lighting that makes them more urgent in their requirements, I cannot say, but we have a very strong demand for more and stronger light in our carriages day by day. As one grows older, it is a thing that one has a great deal of sympathy with, for one finds that to read at all one wants more light, but it is a general demand from all classes and all ages.

Another matter I wish to mention is, that Mr. C. B. Dudley in making his remarks on his paper, stated that one of the points that he thought would come to the front shortly would be the application of turbines on the locomotives to work the lighting by electricity. Some thirteen years ago on the Midland Railway we had working on the locomotive a "Brotherhood" engine, a three-cylinder engine, I think it was, making some 700 revolutions a minute, and that was for working the electric light. It was kept up in various forms for six or seven years, but at that time there was difficulty about the electric lighting and it was abandoned. Of course, since that time things have gone forward a great deal; but I thought it would be interesting just to mention this fact. (*Applause.*)

**Mr. L. Bouët de Journal**, Madrid-Saragossa-Alicante Railway. (In French.) — Gentlemen, I think the reporter has framed his conclusions well in that it is impossible, or anyway extremely difficult, to prove that any one method of lighting is better than another. Electric lighting is really not very costly for maintenance, while gas is dearer and cheaper according to the different districts in which it is produced.

On the other hand, obviously electric light may in certain cases show large differences in the matter of expense. The English companies, for instance, have used electricity extensively and consequently the net cost should be lower in their case than it is for companies who have only tested this method of lighting.

For two years my company has been trying a method of electric lighting with accumulators on twenty-three bogie-carriages and it has proved successful. The net cost per 1,000 candles and per hour is about 1·55 franc (1s. 3d.), 40 per cent being for depreciation and interest, 20 per cent for labour, 15 per cent for upkeep of the dynamo, 11 per cent for upkeep of accumulators, 7 per cent for maintenance of belts and 7 per cent for renewal of lamps. During the two years the light has only failed eight times owing to slipping of the belt. The illuminating power in each car is about 190 candles, i. e., 19 lamps of 10 candle-power each. This is probably lower than with a Welsbach mantle, but the light makes reading in the train

possible. It is generally allowed that 4 or 5 candle-power is enough and ours is considerably above this.

In order to avoid the results of a belt slipping, we have tried to couple the different cars together, *i. e.*, though there is a dynamo and an accumulator to each car, we have arranged for a movable connection between the cars.

On the other hand, the system adopted by my company depends upon a system that differs from the English system. For the latter is based upon the slipping of the belts, whereas ours depends upon breaking contact, a method that at first sight appears quite reasonable; the governor is much simplified and improved by dependence upon electricity for its action. In the Stone system, the dynamo gets into circuit at a moment previously determined by the speed, whereas with the Vicarino system the circuit is only made when the voltage is reached.

The subject of contacts, which has always been a very delicate question with a system more or less left to itself, is likewise very simple because we really have only four contacts. If the problem of electric lighting is to be completely solved, it will, I think, be necessary to invent an appliance to stop accumulators getting further charged when once the proper voltage is reached. The various appliances already invented to limit the charge are unsatisfactory, because their action depends upon raising the voltage of the batteries, which ought to be prevented. It would be well if some appliance could be invented which would render it possible to lower the voltage of the dynamo considerably, once the batteries are fully charged.

**Mr. Ch. Jenny**, South Austrian Railways. (In English and in French.) — On the Austrian railways we have steep gradients, many curves and frequent tunnels. It is therefore no matter of surprise that we are deeply interested in procuring a system of lighting that can be shut on and off as may be requisite.

Trains leaving Innsbrück, for instance, have to be lit throughout from the time they leave, owing to the number of tunnels through which they have to pass. Moreover, the through trains, which are lit with gas, never stop long enough to put out the light and so we have to let their lamps burn till Bozen is reached. This involves considerable expense.

It would be an immense advantage if we could light the train with electricity. The conductor could then turn on the light just before reaching a tunnel and turn it off when the train had got through.

We have studied the subject and we are convinced that the slightly higher cost of electric lighting would be largely counterbalanced by the saving effected if the train were only lit up when required, provided always that the electric light does not fail and does not involve difficulties in shunting the through cars of which there are a great many on international routes.

This is why the Southern of Austrian Railway Company does not yet use electricity for lighting its cars and has so far confined itself to gas lighting with Pintsch lamps.

**Mr. Karl Steinbiss**, German Government. — **Mr. President and Gentlemen**, I find in **Mr. Dudley's** report, this statement :

Considerable experimental work has been done and is now in progress, towards developing a steam turbine electric generator, the plan being to place this generator on the locomotive, and fit each car with a storage battery sufficient to act as an equalizer and for the intervals when the locomotive is detached or unavailable as has already been described.

Gentlemen, we have used this system three years ago on the Hamburg-Berlin line, and we have found that it gave good results. But there is a difficulty. At first, the steam turbine demands much more steam than was calculated, and so it was somewhat dearer. Then the attention of the engine people is divided by watching the electrical apparatus on the locomotive. There you have the turbine and also the electrical apparatus, and we find that the engine people are led off from the observation of the track, etc. So we are now giving up this system, and we have experimented in the last year with another system, which I will show you. There is the armature of the dynamo (*showing a photograph*) which is fixed upon the axle of the luggage van in this manner, and the poles are fixed like that (*showing another photograph*) the pole's supports being fixed on the frames of the trucks. The dynamo produced a current of 200 amperes with a tension of 72 volts and sufficed to illuminate a train of seven cars, each of which was provided with two storage batteries of 32 volts each (64 volts in all). We have got good results with this system, and it is in use on the Berlin and Frankfort and other trains and will be in use on the Berlin-Hamburg trains. We hope that we can use it more and that we can get better results and produce electricity for car lighting cheaper than with the steam turbine electric generator. This is the system of **Mr. Wittfeld**, and is introduced by the *Allgemeine Electricitäts-Gesellschaft* of Berlin, and the electrical part of this apparatus especially is made by **Dr. Rosenberg**. I may say that **Mr. Rosenberg** has brought out a new invention. At first it was necessary for the car attendant to turn the current shifter when the train turned, but now **Mr. Rosenberg** has found a way in the construction of this electric machine by which the car attendant has nothing to do with it. At first he handles the apparatus that gives the current, but thereafter he has nothing more to do with it. The circulation of the current is made by the machine itself. It is automatic in all respects; but the machine gives direct current to the lamps when trains are running, and if the train stops the storage batteries are used.

**Mr. Paul-Dubois**, Orleans Railway, France. (In French.) — Besides various other systems of electric lighting with accumulators, the Orleans Company has equipped about 150 carriages with the Stone system of lighting. This has proved highly satisfactory and the company is now fitting new carriages with this system.

We have also tried on some of the Paris suburban trains what is called the collective electric light.

The capital cost is lower than with the individual system because the number of parts liable to wear and tear are fewer.

Moreover, as these suburban lines are a good deal in tunnel, this method of lighting is considerably cheaper because the light can be turned on and off at will.

The Orleans Company is now planning to extend this system of lighting to most of its suburban rolling-stock.

**Mr. Boell**, French State Railways. (In French.) — For the last seven or eight years we likewise have been using electric lighting on some of our passenger cars on the French State Railways. We first tried accumulators situated under the carriages; they were exchanged at certain stations and recharged.

We soon had to give up this method because conveying the accumulators on trucks put them out of order too quickly and we then decided to use the Vicarino system, which has just been mentioned, on all our heavy cars.

We were the first in France to use this system. At first, we had no small amount of trouble but after a year's groping, we attained the most successful results. We had plenty of break-downs owing to the staff being too inexperienced with electrical fittings, but from the time that we have been able to provide an electrician at each centre, all our troubles disappeared, so that now we are gradually extending the system to all new stock.

On lines with tunnels, gas was rather expensive because on some lines there was no station at which we could stop to extinguish or relight the lamps. It would therefore have been necessary to let the lamps burn much too long, and to avoid this expense we have put in either a Vicarino dynamo on each car, or on some trains that only need to be lighted for a very short time, a single dynamo under the van with hose pipes from vehicle to vehicle.

In the old carriages we have for a long time been using rich gas. Some time ago, after some experiments carried out by the Eastern and Western Companies, we likewise tried lighting with incandescent mantles, with an upright burner, and with an inverted burner, and we found the upright burner gave the better result from the standpoint of the life of the mantle.

The inverted burner gives a pleasanter light in that it casts no shadow; but this method involves more care and consequently we have decided to instal incandescent light in place of all the older lighting, except in the case of new carriages which we equip with electric light.

**The President.** (In French.) — It is so late that we must adjourn the meeting. We shall resume at 2 o'clock and we shall then have to take up ventilation and heating.

---

**Meeting held on May 8, 1905 (afternoon).**

**Mr. G. A. Anderson**, Indian Government. — One of the speakers this morning said that he regarded the electric light as the ideal one for train lighting. If that was so in the West, it would I think be generally conceded that the case for electric lighting was even stronger for Eastern countries, such as India, where any access of heat was a very important consideration. Electric lighting not only has the advantage of coolness, but it also enables the employment of fans and thus greatly reduces the discomfort of travelling in the hot season.

On the main broad gauge lines of India, the percentage of coaches fitted with either gas or electricity is about 82. On the "Bombay, Baroda & Central India" and "Great India Peninsular" systems terminating at Bombay and aggregating considerably over 3,000 miles, the percentage is 95. On four of the larger metre gauge systems, the percentage of coaches fitted with either gas or electricity is about 80. The tendency on the Western Railways, at any rate, is to abandon gas for electricity, leaving the gas lighting to die out on the less important services; a tendency encouraged by the fact that much of the original gas plant is falling in for somewhat extensive renewal and reconstruction.

The systems of electric lighting which have come under my notice, are as follows :

1° *The collective system* (with a dynamo at each end of the train). — This was adopted some eight years ago on the Jodhpore Bikaner Railway, and has been found suitable for the conditions of this desert line of 460 miles with few and regular trains running from point to point without branches;

2° *The accumulator or storage battery system*. — This has been installed on the mail trains of the metre gauge Rajputana Malwa Railway system, 1,650 miles in length. At the outset, the administration were warned to anticipate excessive cost by the use of this system, due to the heavy renewal of batteries that would be required, but by taking care not to run down the batteries, it has worked satisfactorily enough for more than four years, at an estimated cost of about 90 per cent that of gas lighting.

This system was adopted as probably the most suitable to a service involving frequent cutting off for branches, and a considerable demand for lights in coaches standing in sidings. It is now being extended to all passenger trains, and to the station platform lighting at the charging depots of which there are half a dozen. The transfer of batteries causes no trouble or inconvenience;

3° *The Stone system*. — Has not been quite successful so far, owing principally, it seemed to the failure to allow and provide for the varying speeds and grades, which are so common a feature on Indian railways. Messrs. Stone's agent has recently visited India, and has ascertained satisfactorily to himself, I understand, the defects

and how to remedy them, and under the expert advice which has hitherto not been generally available when required, I have little doubt that a satisfactory solution by differentiation of the speed of the dynamo when running and by the addition of assisting batteries, will soon be reached. A system of this kind is favoured by the Main Western Railways, and has been tested on certain special service trains, and it is hoped will soon be extended to the principal long runs in connection with the English mail steamers, such as the Panjab Mail Bombay to Delhi and the Cross Peninsular run, Bombay to Calcutta, each over 1,200 miles in length.

**Mr. da Silva Freire, Brazil Central Railway.** (In English and in French.) — I ask Mr. Verlant, who this morning gave information about the lighting service on his railway — I should like to have some detailed information about the mixed gas apparatus. In Brazil, for a long time we used the Pintsch system. We were quite satisfied with it, but we thought of improving the service a little and we tried to do something similar to what Mr. Verlant has done on the Paris-Lyons-Mediterranean Company. We had some trouble, for the pipes got choked. We wanted draught and we were obliged to stop. As we intended to have something new, we should be very glad if Mr. Verlant will tell us if they made any changes in the disposition of the light. At Rio de Janeiro, we have a heavy passenger service on our suburban lines, nearly 10 million passengers a year — we wanted to have a better service of lighting and introduced the Stone system, with a good result. We have a great many stations, and we have not had any trouble with this system, despite the numerous stops, but we are not going to extend its use, as we think it is too expensive for our country lines. Our lines run 1,200 kilometres (743 miles) into the country. On some of the Brazilian St. Paul railways, they introduced the Stone system ten years ago and are very highly satisfied with it. The service is very good.

I should like to ask a question about the admixture of acetylene with gas. We wanted to try this system, but it has not been a great success. Has not this lack of success been due to the diameter of the Pintsch gas pipes used being too small for the mixed gas? On the Central Railway of Brazil, Pintsch gas is used but on suburban lines, and on the express trains between our large towns the public is beginning to demand a better light. Though our trials of the Stone system have proved successful, we do not intend to continue in that direction, because its cost is too high.

**The President.** — If Mr. Verlant is here we should like to hear him answer Mr. da Silva Freire's question. If not, we will now broaden this discussion and take in the part of the reports which deal with heating and ventilation.

We would like to hear from Mr. Crawford, of the Pennsylvania lines West of Pittsburgh.

**Mr. D. F. Crawford, Pennsylvania lines West of Pittsburgh.** — Our experience West of Pittsburgh follows very closely the work of the lines East of Pittsburgh, as many

of our trains run through from New York to Chicago, and New York to St. Louis, and go over both lines. We are heating all of our trains by steam from the locomotives. The Pullman cars have Baker heaters, so arranged that they can be operated independently of our steam heating system, or operated with it. The Pennsylvania lines, East and West of Pittsburgh, have experimented with the low pressure return system of steam heating, but had so many difficulties with it that the simpler system with the direct pipes has been practically adopted as standard. The principal difficulty we have had with the system has been to obtain a satisfactory hose coupling. During the past winter, we succeeded in obtaining a coupling which has remained tight and holds the steam pressure well, and we feel that our trouble from that cause is overcome.

We have about four hundred coaches on the lines West of Pittsburgh, some two hundred of which are provided with our ventilating system. It has been satisfactory in every way. I personally made some investigations regarding the system and found, as outlined in Dr. Dudley's paper, that the air currents work out as we expected them to; in fact, I was rather surprised that they worked out so well as to the velocity of air obtained, and amount of air used. About the greatest difficulty we have with our steam heating system at the present time, is the regulation of the temperature. Our cars are almost uniformly too hot. The regulation, at the present time, depends entirely on the trainmen and their manual manipulation of the ventilators. As we know, we cannot always rely upon them to give the matter all the attention it should have. We have made some experiments with automatic regulators — thermostats — but while several trains, probably twenty cars, are equipped with such devices, none of them has yet proven sufficiently satisfactory for us to consider them as standard.

**Mr. W. E. Fowler.** — Representing a company which has for the greater part of its territory a country which has extremely low temperature at times, I am interested in some features of this subject, which perhaps have not yet been presented. I infer from reading Mr. Dudley's paper that he thinks that the direct steam system is the ideal one. I agree with him on most counts, but I think there was some reference made this morning to the fact that no sleeping cars have been equipped with this system. I would ask why? My idea is that the Pullman Company, or any other company which has a large number of cars, finished on the inside with veneers of any kind, would object to the fluctuations in temperature which a car heated with direct steam must be subjected to; that is, a car which, during the day is heated to a temperature of 70 or over, if heated by direct steam, would have the steam cut off entirely, and in our climate that would mean that the temperature on the inside of the car when the car was uncoupled at night, would go down possibly to 40° below zero. That would be very detrimental to the veneers and varnish on the inside of the car. I should like to hear from some of the other delegates as to their experience. While I am in favour of direct steam heating as

being most economical and satisfactory on general principles, there are some features of climate and operation which do not seem to admit of the direct steam system.

**Mr. D. F. Crawford.** — The majority of Pullman cars which I have examined have the Baker heater system, with water circulating in the pipes and then a jacket to which the steam is supplied, which secures a continuous water-circulation. Others have a commingler system, where the steam heats the water in the Baker heater pipes. I do not know of any Pullman cars having direct radiators such as are used in the ordinary coaches.

**Mr. W. E. Fowler.** — I do not think I made myself clear. By the expression direct steam heat, I meant the system Mr. Crawford referred to, of direct radiation, the carrying of the steam into the heater pipes in the car, and not that of using the steam to heat the water in the pipes. That system which does not include the use of water in the pipes, is the one which is coming rapidly to the front as being very convenient in more ways than one. Although our company does not use it now, I consider it one of the best methods of heating cars. The steam is taken into the train pipe, it goes up into the car and circulates through two series of pipes (more or less, according to the climate), and the condensation will be carried out through the drip pipe, under the cars. That is the system I mentioned as being unsuited to cars which were finished with veneers, as we find that system of heating is unsuitable for cars that are veneered.

**Mr. Brisse.** (In French.) — The Eastern Company has investigated and has for many years past tried a system of heating that might be classified as mixed : for heating it involves the use of steam taken from the engine and as a dynamic force the compressed air supply by the locomotive's air pump.

The use of a mixture of compressed air and steam was suggested by Mr. Lancrenon, assistant chief engineer in our locomotive and rolling stock department, to meet the requirements of heating trains of great length. Steam heating alone, used on various railways in Europe and especially on the Swiss and German lines, caused various inconveniences when the length of trains exceeded certain limits. At one time in France, it became necessary to heat suburban trains throughout; these trains had seating capacity for 1,200 or 1,400 and their length was considerable. It was therefore necessary, and even absolutely indispensable, to find some method of heating that could be applied to trains with the maximum number of cars allowed on French trains, that is to say twenty-four four-wheeled carriages.

For this purpose, we first tried using a mixture of compressed air and steam on these trains of great length and then gradually and quite recently it has been extended to all the trains throughout the French Eastern Railway's system.

The main advantage of the compressed air method, is that the heating medium can be conveyed through a pipe of small enough calibre. Secondly it was possible

to use a method of heating, preferred by the public in France, namely one that entered below the feet. For a long time, French passengers had been accustomed to heating by tins and it seemed well to continue this method, in conjunction moreover, as we have done, with heating by radiation either through pipes with perforated cases, situated under the seats, or even through cased pipes with smaller openings for vehicles which had no side doors.

Our experience on the Eastern Railway has proved that this method can be used on trains of great length. The improvements invented by Mr. Lancrenon have further enabled us to combine, on some of our trains which are made up with carriages intended for international traffic, and which have to be heated on the German lines by steam alone, and on the French lines by a mixture of steam and compressed air, pipes whose calibre is sufficient to admit of the use of either the steam alone or of a mixture of steam and compressed air.

In addition, the use of compressed air has enabled us to ensure regularity and safety, during time of frost, in clearing out the pipes.

Originally objections might have been raised against this method, because only a moderate amount of heat could be supplied in the compartments, but since the recent improvements, we have found it possible to extend this method of heating to international trains of great length and even with night temperatures falling as low as  $-13^{\circ}$  C. ( $5^{\circ}$  Fahr.) we have been able to get an average temperature of  $20^{\circ}$  C. ( $-4^{\circ}$  Fahr.) in the compartments on a train consisting of sixteen to eighteen four-wheeled coaches or eight to ten eight-wheeled coaches. And yet the consumption of fuel was not excessive, nor did the driver experience any serious difficulty in ensuring the heating of so long a train.

Unfortunately, I can give you no actual details about the fittings themselves, but I think these would be superfluous as the installation is well enough known.

**Mr. H. Tylston Hodgson.** — I do not see any English locomotive engineers here this afternoon. Therefore, although I am not a technical engineer in any way myself, I should not like this discussion to pass without drawing attention to one or two of the points which are difficult to us, and which may not be so to others. Our journeys are not so long as those of many other countries. The cold and heat in England is not so severe, and consequently travelling with or without heat is not perhaps such a matter of life and death, but it is a matter of comfort or discomfort. We have kept up the controversy about continuous heating and the use of the old fashioned foot warmers year by year, and to-day there is no great consensus of opinion. We are to-day using both the continuous heating and the foot warmers in England. We have a large number of carriages of small length, with side doors. We have others corridor carriages, with end doors, and of very considerable length. In the case of the small carriages with side doors the old foot warmer to-day to many gives more satisfaction than the continuous heating. In the case of the long carriages, which have been introduced more and more of late years, satisfactory

heating by the use of foot warmers becomes more and more difficult. One of the difficulties we have had, also, is that our climate is so variable, if it can be called a climate at all. I am truly patriotic, but I must say that it seems to me our climate is composed of bits of climate from everywhere, from all over the world, and day by day we have changes in the atmospheric conditions, and in the temperature, which we can never foresee. If we make elaborate preparations for great heat to-day, we shall surely get great cold to-morrow. Therefore, the difficulties of those countries which get continuous spells of severe weather, are not known to us. There has been considerable controversy as to whether the main pipe carrying the steam from the locomotive throughout the train should be put through the carriages or taken outside. Some of the locomotive authorities have objected to taking it outside saying that this adds to the consumption of the steam as it no doubt does. On the other hand, if it is taken into the carriages, it cannot be completely cut off from any one compartment, as it is often desired should be done. Therefore, there is a variety of practice and many carriages are made with the conduit passing the steam right through the compartments, and that part of the heating cannot be cut off, and we have radiators for the additional warmth of compartments, and that part can be cut off. That is a controversy which is still going on in England. I do not know that there are any other points in which we differ from your practice. Had there been some technical speaker who could have explained these matters, I should have been thankful, but I did not want to have this subject passed by without something being said about the practice in England.

**Mr. Hodeige**, Belgian State Railways. (In French.) — We still use hot water tins on the Belgian State Railways. But, for some time we have been trying heating by steam taken from the engine and we have found this method fairly satisfactory.

We have also tried the Lancrenon system; but as our experiments are still going on, I cannot yet tell you with what results.

**Mr. A. E. Mitchell**, Lehigh Valley Railroad, United States. — On the Lehigh Valley Railroad, we have practically direct steam heating on all of our cars. We have also stationary plants where we can heat all cars cut off at terminal points. This avoids the necessity of utilizing the Baker heaters or the water circulating system in order to maintain the heat in our cars. We have 132 cars now equipped with the Baker heater system, and we have found that we have never had to build a fire in these heaters for something over two or three years, and I am now taking out the Baker heaters from those cars, and introducing one extra seat in the space which the Baker heater formerly occupied. In other respects, our practice is substantially the same as on the rest of the roads of this country.

It may be interesting, however, for some of the delegates, to understand what the American practice is. Some three or four years ago, almost all of the train line steam pipes under our passenger cars were located beneath the floor, thoroughly insulated, some being placed below the sills and others between sills. About three

or four years ago, a committee was appointed by the Master Car Builders' Association to investigate whether or not an 1 1/2-inch train line was sufficient in size to give us the proper amount of steam at the rear of a long train. Experiments were carried out by this committee, with the result that the committee recommended to the Master Car Builders' Association that a 2-inch train line be substituted for the 1 1/2-inch pipe. Some of the railroads, especially the Vanderbilt lines, have introduced the 2-inch train line pipe very largely, and the only objection which has been found to the enlarged pipe system has been the enlarged hose, and the larger couplings, and the greater difficulty in coupling and uncoupling same. I understand that the roads which have introduced the 2-inch steam train line pipe have in many cases put in reducers at the ends of the pipes and use the usual 1 1/2-inch steam coupling.

**Mr. W. E. Fowler.** — I wish to say a few words supplemental to what Mr. Mitchell has said in regard to the 2-inch train line. There are two trunk lines, other than the Canadian Pacific which have practically adopted the 2-inch train line with the large hose and coupler. We made a test of the 2-inch train line, with the large hose and coupler in March, 1904, and the results obtained then were so attractive that in the fall of last year the management concluded to equip the whole of the passenger cars with the large hose and coupler; and I merely wanted to say that in our climate, where we have temperature along the north shores of Lake Superior and the plains of the Northwest, from 50 to 60° Fahr. below zero, it is the only system we have found which would enable us to heat trains of ten or twelve passenger cars, each car 65 to 72 feet long, and enable us to heat the rear car as well as the front car.

**Mr. Thomas Bonayne,** New Zealand Government Railways. — Mr. President, we have a fairly cold climate, and are rather behind the times and old-fashioned. We are using the acetate of soda footwarmers similar to those used in England. We are, however, contemplating the use of steam, and I have no doubt that in the course of time we shall use steam. As the present heaters wear out, it is the intention of the department to go into steam heating, using the best system, such as is in use in the United States and other countries. Our southern climate is somewhat severe, not so bad as 60° below zero, but we get 10 or 15°, which is quite cold enough.

As to the ventilation of cars, we have a little experience in that direction. In the north island the railway passes through a considerable extent of country which is affected with a very fine dust. The formation on the line is pumice, and the impalpable dust will penetrate through almost anything. The windows of our present carriages are all single sashes but, double-sashes are about to be tested with a view of minimising the dust nuisance. We found considerable difficulty with regard to the dining car. While passengers in the ordinary carriages are inconvenienced by the dust, they have found it very desirable to be able to enjoy food that was free from dust and grit. So our chief mechanical engineer made some experiments, and the air is taken in at the top of the car, as in your system, then led down to floor level where it is filtered through loosely woven canvas cloths, which cloths are kept

wet, thereby cooling and purifying the air. Provision was also made for the further cooling of the air by using ice; but we found that by passing the air through the wet cloths the objectionable dust was intercepted, and we get a fair supply of cool air in the car. The hot air, of course, is exhausted through the roof in the usual way by torpedo ventilators, which we use very largely. Then as regards the ventilation of the ordinary cars, we have a system by means of which the ventilation is fairly good. There are inlets passing up through the side of the car, between the two linings, the outer sheet and the inner one, and at spaces along the ledge of the car there are slides which the passenger can control and admit fresh air or shut it out at his pleasure, and the hot air there is also exhausted by means of the torpedo roof ventilator. In the smoking cars there is a row of fixed spittoons down the center, with a large hole, about  $1\frac{1}{2}$  inch, and a supply of fresh air comes up through there. In those of our cars which are electrically lighted, electric-fans are successfully used as an aid to ventilation.

I do not think there is anything further that I can add, Mr. President.

**Mr. C. Peter Clark**, American Railway Association. — Mr. President, I will take but a moment to say what may possibly be of interest to the gentlemen present. I heard nothing said here of economy in the use of steam in heating trains. Some roads in this country are successfully experimenting with the heating of trains by the exhaust from the air pump. With quite cool temperatures sufficient steam is obtained to heat a train of seven or eight, or even nine, cars, without drawing directly from the boiler. Of course, the amount of heat available depends upon the frequency of stops and the irregularity of the grades. The apparatus is exactly the same as that used for the direct steam, and it is a simple matter for the engineer to close the valve connecting with the pump exhaust, and admit live steam in case the temperature is down; but when the temperature of the cars is once raised to a satisfactory point it requires, as most of us know, very little steam to keep the temperature up if it is allowed to pass freely. The objection is made that it introduces an element of back pressure against the pump, but in practice this is found to be a very slight factor. On the other hand (in speaking of the application to American practice), it takes out of the stack of the locomotive the exhaust of the pump, which we usually put there, and which has a tendency to blow up the fire at a time when we have no use for steam, while stopping at stations, and probably, in that way, effects a saving which offsets all of the back pressure. It is true that locomotives are continually asked to haul heavier trains and move them faster. Extreme cold weather is the hardest time of the year to call upon the locomotive for even the small amount of steam needed to heat the train, and some roads are finding that this is quite a convenient way of utilizing this waste steam and saving the coal pile.

**The President.** — If nobody wants to speak any further on the question, the sectional officers desire to propose the following provisional resolutions :

“ As regards lighting, the Congress notes the development of the use of

incandescent mantles, heated by oil gas and sometimes by common gas, and of different systems of electric lighting. Cylindrical mantles seem to be somewhat stronger than globe mantles, but the latter distribute the light somewhat better. Various types of mantles are used in Europe by different managements, especially in France and Germany, and are beginning to extend to the United States.

“ Though the cost of electric lighting is still very high, the various systems give satisfaction on several administrations. Attention is called to their advantage in certain cases for intermittent lighting, in passing through tunnels and operating driving fans.

“ Acetylene gas has been used mixed with Pintsch gas, especially in France and Germany, but a tendency is observed to abandon this mixture, owing to the use of mantles. On the other hand, mention is made of the use in America of pure compressed acetylene, with some special precautions.

“ Steam heating has a tendency to extend in different countries. To obtain sufficient heat for very long trains, or in cases of very low temperature, care is taken to use either pipes of sufficient diameter or compressed air mixed with steam.

“ The adoption of a uniform coupling for all the cars in the same territory, is an important question to be solved.

“ The Congress notes the different systems of car ventilation that have been applied, especially that in use on the Pennsylvania Railroad. ”

These conclusions would seem to embrace nearly all the remarks that have been made, but there will also be a full report of them drawn up.

**Mr. Dragu**, Rumanian State Railways. (In French.) — I hope that you will leave out the sentence concerning the cost of electricity, unless you add that the additional expense of electric lighting is counterbalanced by the marked advantages of this method, the current being also useful in summer for ventilating purposes.

**The President.** — We might leave out the question of cost from the conclusions as it might seem to discredit electric lighting, and state that “ systems of electric lighting are giving satisfaction on different roads. ” (*Carried unanimously.*)

Then the conclusions will provisionally read as follows :

“ As regards lighting, the Congress notes the development of the use of incandescent mantles, heated by oil gas and sometimes by common gas, and of different systems of electric lighting. Cylindrical mantles seem to be somewhat stronger than globe mantles, but the latter distribute the light somewhat better. Various types of mantles are used in Europe by different managements, especially in France and Germany, and are beginning to extend to the United States.

“ Systems of electric lighting are giving satisfaction on different roads. Attention is called to their advantage in certain cases for intermittent lighting, in passing through tunnels and operating driving fans.

“ Acetylene gas has been used mixed with Pintsch gas, especially in France and

Germany, but a tendency is observed to abandon this mixture, owing to the use of mantles. On the other hand, mention is made of the use in America of pure compressed acetylene, with some special precautions.

“ Steam heating has a tendency to extend in different countries. To obtain sufficient heat for very long trains, or in cases of very low temperature, care is taken to use either pipes of sufficient diameter or compressed air mixed with steam.

“ The adoption of a uniform coupling for all the cars in the same territory is an important question to be solved.

“ The Congress notes the different systems of car ventilation that have been applied, especially that in use on the Pennsylvania Railroad. ”

— These conclusions will be submitted to the general meeting.

— The meeting adjourned at 3:30 p. m.



## DISCUSSION AT THE GENERAL MEETING

---

Meeting held on May 11, 1905 (afternoon).

---

MR. STUYVESANT FISH, PRESIDENT, IN THE CHAIR.

GENERAL SECRETARY : MR. L. WEISSENBRUCH.

ASSOCIATE GENERAL SECRETARY : MR. W. F. ALLEN.

Mr. H. Tylston Hodgson, *president of the 3<sup>rd</sup> section*, read the

### Report of the 2<sup>nd</sup> and 3<sup>rd</sup> sections meeting jointly.

(See the *Daily Journal of the session*, No. 6, p. 107.)

“ MR. C. B. DUDLEY summarized his report on the lighting, heating and ventilation of trains. This report shows that the use of candles is being abandoned, except in cases of emergency, and the same is largely true of oil lamps. The carburator system seems to have given good results on branch lines. The use of oil gas is being largely extended, while that of coal gas is disappearing. At the present time 25,000 to 26,000 cars in the United States are lighted with oil gas, and this number tends to increase. Electric lighting has been tried on a large scale under five distinct forms :

“ 1° By the use of movable storage batteries;

“ 2° By the use of storage batteries placed permanently under the cars and charged during stops of the latter;

“ 3° By the use of dynamos operated by the motion of the car axle;

“ 4° By the use of a dynamo placed in a baggage car;

“ 5° By means of a steam turbine driving a dynamo placed on the locomotive. This last system has been tested only in a few cases.

“ It did not seem possible to the reporter to render at this time a final decision on these different systems.

“ Acetylene lighting has been tried under three forms :

“ 1° With acetylene generators hung under the cars;

“ 2° With receivers holding compressed acetylene;

“ 3° With acetylene dissolved in acetone, in cylinders containing some absorbent material, such as disks of asbestos.

“ Electricity seems to be the most economical system as regards consumption, but it is difficult to give figures regarding the cost of maintenance of the apparatus.

“ As for car heating, in the reporter's opinion, the best method is to use steam from the locomotive, and he particularly recommended the Baker system, which admits of the use of either steam or coal, as may be desired. The proper diameter to be used in the pipes and the arrangement of the couplings are the most delicate points in the equipment, and the reporter called attention to the systems shown at the Washington Railway Exhibition, which provide for coupling simultaneously and automatically the pipes for the steam, air and alarm connections.

“ On the subject of ventilation, the reporter remarked that a good system should work both in summer and winter, and should be properly harmonized with the heating system. He described the system used on the Pennsylvania Railroad, whereby the air is taken from outside, under the flooring of the cars, is heated by radiators and admitted inside the car through openings under the seats and passed off through ventilators in the roof. For further details he referred to his report.

“ The secretary then read the conclusions from the report presented on the same subject by Mr. Cajetan BANOVITS which were as follows :

“ In consequence of the continual improvements and advances made in the lighting, heating and ventilation of railway carriages, the general average level of these appliances has steadily improved during the last few years.

“ Nevertheless, appliances are still largely used, which satisfy the reasonable requirements of passengers only very inadequately or very moderately.

“ The better and more improved appliances may be divided into two groups; the one comprises the appliances which owing to their efficiency can satisfy all requirements, however exacting, but which require separate attention, and can consequently only be used with advantage in special cases, and not where there is much traffic; the other comprises the appliances which can satisfy all modern requirements, and owing to the simplicity of their manipulation, are suitable for the best trains, and allow a large amount of traffic to be dealt with readily and expeditiously. It is self-evident that in such appliances also further improvements are still to be made.

“ To the second group, which is most suitable for the improvement of deficient appliances, belong :

“ a) As regards lighting : gas, mixed gas and electric lighting ; the last, owing to its many advantages, is worthy of special attention and its use should be extended as much as possible;

“ b) As regards heating : the various systems of steam heating, the steam and the condensed water conduction being kept as separate as possible, or even separate piping being provided for carrying off the condensed water;

“ c) As regards ventilation : the roof ventilators, with their action increased as much as possible by combining them with pipe ventilators; in this connection, it should also be noted that it is desirable to supplement the ventilation by providing for the supply of fresh air in addition to removing the foul air.

“ Finally, it must be emphasized that for these reasons also, special importance must be attached to the proper and suitable design of the carriages, as not only is the proper working of the appliances mentioned above better ensured, and consequently the legitimate demands of passengers realized, by this means, but the safety of the traffic is also increased. ”

“ Discussion was opened on the subject of lighting.

“ Mr. WICKERSHEIMER (*French State Railways*) asked for some details on the use of acetylene gas, which, when under low pressure, did not seem to him dangerous, and, particularly, whether freezing of generators on cars cannot be prevented by adding a certain proportion of alcohol to the water.

“ Mr. Max TOLTZ (*Manistee & Grand Rapids Railroad*) gave an account of experiments made with a system designed by himself conjointly with Mr. Lipschutz. In this system, they use acetylene compressed to 10 atmospheres in receivers hung under the cars, and to avoid explosions arising from the heating of the gas each receiver is fitted with a number of fusible plugs. To avoid heating of the gas during its compression, the latter is effected in three successive periods, and the gas cooled after each compression. This system is being used at the present time on a large scale by the Great Northern Railway (United States) and the Canadian Pacific Railway, and no serious accident has so far occurred.

“ Replying to the question previously asked by Mr. Wickersheimer, Mr. Max Toltz said that, as far as he knew, only glycerine has been used to prevent freezing.

“ Mr. W. E. FOWLER (*Canadian Pacific Railway*) confirmed the information given by Mr. Max Toltz on the subject of his system, which is now in use on 369 cars of his company, and is working there in a very satisfactory manner, without having caused any accident. He stated that this system gives three times as much light as oil lamps for the same expense.

“ In reply to an inquiry from Mr. BRISSE (*French Eastern Railway*), Mr. W. E. FOWLER stated that the Toltz system did not give any more trouble or inconvenience than the Pintsch system as regards charging the tanks at stations.

“ Mr. R. FANE-DE-SALIS (*North Staffordshire Railway, England*) described a system of obtaining acetylene gas without water by mixing calcium carbide with bicarbonate of soda. This process, which avoids any trouble in regard to freezing, has only

been employed for stationary apparatus up to the present time, but he thinks it would be interesting to try its application to lighting of cars.

“ Mr. VERLANT (*Paris-Lyons-Mediterranean Railway*) stated that his company, which has in its cars about 25,000 lamps burning a rich gas, has improved its lighting in the last few years by mixing this gas with 20 to 25 per cent of acetylene. A further improvement has been attempted by using incandescent mantles, but as these wear out quickly with acetylene, and as the fact that two generating plants are required (one for gas and one for acetylene), it is a disadvantage. Mr. Verlant thinks that with incandescent mantles it is preferable to give up using acetylene.

“ Mr. BRISSE reported that the French Eastern Railway has decided to adopt, on its entire rolling stock, the use of rich gas with incandescent mantles. This method of lighting, while giving a greater illuminating power than ordinary gas burners, secures at the same time a very marked saving. Two designs of tips are used — the straight burner and the reverse burner. The latter gives a more satisfactory appearance, but the life of the mantles is much longer with the former.

“ Mr. J. J. W. VAN LOENEN-MARTINET (*Dutch Railway*) said that his line has been using for the last eight years oil gas mixed with 15 per cent acetylene, but that a serious explosion occurred in a stationary acetylene plant used for lighting a station, and it was thought more prudent not to extend the use of this system. They resorted, therefore, to electric lighting by the Stone system, with which 10 per cent of their cars are now equipped. According to the speaker, the net cost of this method of illumination, without allowing for depreciation, is 20 per cent greater than that of gas mixed with acetylene.

“ Mr. R. SARRE (*German Government*) stated that in Germany the mixture of rich gas and acetylene is extensively used, but owing to a very severe explosion some years ago in Strasburg, the cause of which could not be ascertained, it has been decided to seek some other process. They have consequently begun to experiment with incandescent burners, using, however, two mantles for each lamp.

“ Mr. W. CLOW (*Great Central Railway, England*) expressed the opinion that electric light gives the best results. Out of 1,631 cars belonging to his company, 50 per cent are lighted with electric light, 40 per cent with gas and 10 per cent with oil.

“ Mr. H. Tylston HODGSON (*Midland Railway, England*) recalled that thirteen years ago his company experimented with a Brotherhood engine driving a dynamo set on the locomotive, but after a few years they abandoned this arrangement.

“ Mr. L. ROUËT DE JOURNAL (*Madrid-Saragossa-Alicante Railway*) gave very complete data on the Vicarino system of electric lighting as applied to 23 cars belonging to his company. The net cost of this system would be of 1.55 franc (1s. 3d.) per

1,000 candle-power (French measure) per hour, 40 per cent of this being charged to depreciation and interest, 20 per cent to operation, 15 per cent to maintenance of dynamos, 11 per cent to maintenance of accumulators, 7 per cent to keeping up belts and 7 per cent to maintenance of lamps. A number of cases of slipping of belt have been experienced, and to avoid the consequences, they propose to try coupling the different cars to each other. The speaker thought it would be advantageous to devise some arrangement for stopping the process of charging the accumulators when the necessary voltage is reached.

“ Mr. Ch. JENNY (*South Austrian Railways*) thought that electric lighting would be particularly advantageous for lines having numerous tunnels, to save the expense resulting from the prolonged burning of gas lamps.

“ Mr. Karl STEINBISS (*German Government*) described two interesting experiments in electric lighting. The first, undertaken three years ago, consisted in driving a dynamo by a Laval turbine, mounted on the locomotive. The lighting worked well, but the consumption of steam was excessive, and the care of the electric apparatus required much attention from the engine crew. This system was therefore abandoned and a dynamo mounted on the wheels of a car was tried, according to an arrangement devised by Messrs. Wittfeld and Rosenberg. The dynamo produced a current of 200 amperes with a tension of 72 volts, and sufficed to illuminate a train of seven cars, each of which was provided with two storage batteries of 32 volts. This system seems likely to give excellent results.

“ Mr. F. PAUL-DUBOIS (*Orleans Railway*) stated that his company is very well satisfied with the Stone electric lighting system, which is at present installed in 150 cars. Some suburban trains are lighted by means of a single dynamo set up in the baggage car.

“ Mr. C. BOELL (*French State Railways*) reported that after having tried electric lighting without great success by movable accumulators, his management has adopted for the principal trains the Vicarino system, which gives excellent results. The majority of cars on his system are furnished with rich gas burners, which will be improved by the use of incandescent mantles.

“ Mr. G. A. ANDERSON (*Indian Government*) remarked that one of the speakers had said that he regarded the electric light as the ideal one for train lighting. If that was so in the West, it would be thought be generally conceded that the case for electric lighting was even stronger for Eastern countries, such as India, where any access of heat was a very important consideration. Electric lighting not only has the advantage of coolness, but it also enables the employment of fans and thus greatly reduces the discomfort of travelling in the hot season.

“ On the main broad gauge lines of India, the percentage of coaches fitted with either gas or electricity is about 82. On the “ Bombay, Baroda & Central India ” and “ Great Indian Peninsular ” systems terminating at Bombay and aggregating

considerably over 3,000 miles, the percentage is 98. On four of the larger metre gauge systems, the percentage of coaches fitted with either gas or electricity is about 80. The tendency on the Western Railways, at any rate, is to abandon gas for electricity leaving the gas lighting to die out on the less important services; a tendency encouraged by the fact that much of the original gas plant is falling in for somewhat extensive renewal and reconstruction.

" The systems of electric lighting which had, he said, come under his notice were as follows :

" 1° *The collective system* (with a dynamo at each end of the train). — This was adopted some eight years ago on the Jodhpore Bikaner Railway and has been found suitable for the conditions of this desert line of 460 miles with few and regular trains running point to point without branches.

" 2° *The accumulator or storage battery system*. — This has been installed in the mail trains of the metre gauge Rajputana Malwa Railway system, 1,650 miles in length. At the outset, the administration were warned to anticipate excessive cost by the use of this system, due to the heavy renewal of batteries that would be required, but by taking care not to run down the batteries, it has worked satisfactorily enough for more than four years at an estimated cost of about 90 per cent that of gas lighting.

" This system was adopted as probably the most suitable to a service involving frequent cutting off for branches and a considerable demand for lights in coaches standing in sidings. It is now being extended to all passenger trains, and to the station platform lighting at the charging depots of which there are half a dozen. The transfer of batteries causes no trouble or inconvenience.

" 3° *The Stone system*. — Has not been quite successful so far, owing principally, it seemed to the failure to allow and provide for the varying speeds and grades, which are so common a feature in Indian railways. Messrs. Stone's agent has recently visited India and has ascertained satisfactorily to himself. Mr. Anderson understands the defects and how to remedy them, and under the expert advice which has hitherto not been generally available when required, Mr. Anderson had little doubt that a satisfactory solution by differentiation of the speed of the dynamo when running and by the addition of assisting batteries, would soon be reached. A system of this kind is favoured by the Main Western Railways, and has been tested on certain special service trains, and it is hoped will soon be extended to the principal long runs in connection with the English mail steamers, such as the Panjab Mail Bombay to Delhi and the Cross Peninsular run, Bombay to Calcutta, each over 1,200 miles in length.

" Mr. J. J. DA SILVA FREIRE (*Brazil Central Railway*) informed the section that the system of lighting by Pintsch gas has been in use for a long time in Brazil, and that an attempt had been made to obtain a better light by mixing acetylene gas with the Pintsch gas, which, however, did not give satisfactory results.

“ The speaker inquired whether others had made similar experiments, and thought that the want of success on the Brazilian railroads was due, at least in part, to the smaller diameter of the pipes used.

“ On certain lines, especially on the St. Paul Railway System, the Stone system has been in use for the past ten years with very good results. Unfortunately this system is costly. The Brazilian railroads are always on the look out for a better light, provided that it will not cost too much.

“ Mr. D. F. CRAWFORD (*Pennsylvania Lines West of Pittsburgh*) stated that, on his system all the trains are heated by steam from the locomotives. The Pullman cars are in addition equipped with fixtures which enable them to be heated either by a hot water system, or by steam from the locomotive.

“ The Pennsylvania Railroad has experimented with steam at low pressure, and the main difficulty has been to find good coupling connections.

“ In the matter of ventilation, about 200 passenger cars out of the 400 in service on the Pennsylvania Lines West of Pittsburgh, are being operated upon the system of ventilation described in Mr. C. B. Dudley's report, with excellent results.

“ The greatest difficulty encountered in the system of direct heating by steam, is in regulating the temperature in the cars. Automatic regulators have been tried in several cars, but have not shown good results up to the present time, and the cars are generally overheated, so that the temperature has to be regulated by the train staff.

“ Mr. W. E. FOWLER (*Canadian Pacific Railway*) stated that his company is very much interested in the question of heating the trains, because of the extremely low temperatures in certain territory through which that system runs.

“ The direct heating system, described by Mr. C. B. Dudley, is not used by the Pullman Company, and he attributes this to the fact that this company has cars with panels of very expensive woods, and that the difference in temperature between the periods during which the cars are in motion and those during which they are stationary, would soon destroy the panelling.

“ Mr. C. B. DUDLEY, reporter, replied that the direct system of heating by steam is used in the Pullman cars if by the direct system, is understood one in which each car is supplied with the necessary steam from a main pipe coming from the locomotive and extending from one end of the train to the other, the condensation water being discharged on to the track through a special valve.

“ Mr. D. F. CRAWFORD replied that the Pullman Company uses the steam heating system, but also each car has a hot water system which enables the temperature to be maintained during stops.

“ Mr. W. E. FOWLER understood by direct heating the use of the steam as it comes from the locomotive, and again expressed his opinion that this system is inadvisable in cars with costly wood panels.

“ Mr. BRISSE informed the section that the French Eastern Railway has experimented with a mixed heating system, using steam and compressed air supplied by the air pump of the locomotive, a system which was invented by Mr. Lancrenon to meet the necessity of heating trains of great length. The use of steam alone presented very great difficulties, especially in the suburban service of Paris, where trains frequently consist of 24 units on two or three axles each. This heating system has been gradually extended on all trains of the Eastern Railway. It has the advantage of permitting a reduction in the diameter of the pipes. The hot mixture is conducted under the feet of the passengers, which is preferred in France, and is carried also either along the sides or under the seats, where it produces heat by radiation. In the cars in the international service, this system permits also heating by steam alone when outside French territory. The improvements made by the inventor of this system enabled the road to maintain in its cars during last winter an average temperature of 20° C. (68° Fahr.) when it was minus 15° C. (5° Fahr.) outside. With this system, no especial difficulty is experienced in maintaining pressure.

“ Mr. H. Tylston Hodgson called the attention of the meeting to the fact that in England the differences in temperature, though sudden, are never very excessive. There is no extreme cold, and opinions are divided between the use of hot water heaters and steam heating. Two types of cars are in general use on the railroads of Great Britain, and the heating systems are applied according as the cars have a central passage or side doors. In cars of the first type, it is difficult to use water heaters, but in the second, they give general satisfaction. Opinions are also divided as to the best location of the main steam pipe. If it is placed outside the cars a great loss of heat is occasioned, but, on the other hand, if placed inside it becomes impossible to isolate a car placed in the middle or at the front of the train. This trouble is avoided when each car is equipped with its own radiating apparatus fed by an external pipe.

“ Mr. HODEIGE (*Belgian State Railway*) stated that a certain number of water heaters are still in use in Belgium, where, however, they have begun to use the system of heating by steam taken from the locomotive as well as the system described by Mr. Brisse. Belgium still being in an experimental stage, the speaker regretted not being able to recommend any system.

“ Mr. A. E. MITCHELL (*Lehigh Valley Railroad*) stated that a direct heating system by steam is in use on all cars of his company; at the yards, special generators are installed, which furnish the steam necessary to maintain the temperature in cars during long stops. This innovation has permitted the abandonment of the hot water system with which 132 cars were previously equipped, which has resulted in gaining two seats in each car. Several years ago, a commission was appointed by the American Master Car Builders' Association to determine whether the main

pipe of 1 1/2 inch in diameter, which had been previously used, was sufficiently large. This committee recommended the adoption of pipes 2 inches in diameter, which were then installed on certain lines. The main objection to pipes of 2-inch diameter, is that they require coupling connections of the same diameter, which are difficult to keep in order. In some cases, these pipes are supplied with reducers, thus permitting the use of connections with pipes of 1 1/2 inch diameter.

“ Mr. W. E. FOWLER informed the session that the Canadian Pacific has equipped all its cars with 2-inch train pipes and couplings of the same size. It is due to this large diameter that they have succeeded in keeping up a comfortable temperature in their cars, when the temperature outdoors is 60° below zero (Fahrenheit), as happens at times along Lake Superior.

“ Mr. Th. RONAYNE (*New Zealand Government Railways*) stated that the lines in his country generally use systems of foot warmers for car heating, although they are now considering the introduction of a system of steam heating. In the southern island especially, the cold at some seasons is quite severe.

“ While the New Zealand Railways have had little experience in the matter of heating, they have had occasion to study the system of ventilating cars. In some parts of the territory through which they run, the air is full of a very fine white dust, which penetrates everywhere. All the cars are supplied with double windows. In dining cars especially, the air is admitted through openings in the side panels through a strainer, and in many cases it is cooled with ice. This system has given very satisfactory results. Ordinary coaches are ventilated through openings in the sides fitted with two slides, which passengers can lower or close as they desire.

“ Mr. C. P. CLARK (*American Railway Association*) observed that nothing had been said about the economy of using steam for heating trains. Some companies have tried to utilize the exhaust steam from the vacuum pumps on the locomotive and obtained very fair results. As the radiators are the same as those used in other steam heating systems, it is easy for the engineer to turn live steam into them when the temperature gets too low. The chief objection to this system is that it causes back pressure on the steam piston of the vacuum pump. This objection, however, is unimportant. On the other hand, at least in American practice, it obviates the necessity for discharging the exhaust steam from the vacuum pump through the stack of the locomotive and thus avoids an irregular draft on the fires.

“ Discussion having ceased, the PRESIDENT proposed the adoption of the following conclusions. ”

**The President.** — The following are the

**CONCLUSIONS.**

“ As regards lighting, the Congress notes the development of the use of incandescent mantles, heated by oil gas and sometimes by common gas, and of different systems of electric lighting. Cylindrical mantles seem to be somewhat stronger than globe mantles, but the latter distribute the light somewhat better. Various types of mantles are used in Europe by different managements, especially in France and Germany, and are beginning to extend to the United States.

“ Systems of electric lighting are giving satisfaction on different roads. Attention is called to their advantage in certain cases for intermittent lighting, in passing through tunnels and operating driving fans.

“ Acetylene gas has been used mixed with Pintsch gas, especially in France and Germany, but a tendency is observed to abandon this mixture, owing to the use of mantles. On the other hand, mention is made of the use in America of pure compressed acetylene, with some special precautions.

“ Steam heating has a tendency to extend in different countries. To obtain sufficient heat for very long trains, or in cases of very low temperature, care is taken to use either pipes of sufficient diameter or compressed air mixed with steam.

“ The adoption of a uniform coupling for all the cars in the same territory is an important question to be solved.

“ The Congress notes the different systems of car ventilation that have been applied, especially that in use on the Pennsylvania Railroad. ”

— These conclusions were adopted by the general meeting.

---

# MISCELLANEOUS INFORMATION

[ 313.385 (.3) ]

## 1. — The world's railways.

(Archiv für Eisenbahnwesen.)

As in previous years, we print below a table showing the growth of the world's railway lines between 1900 and 1904 and another table exhibiting the cost of their construction.

Table I. — The railways of the world from the end of 1900 to the end of 1904, and the ratio of mileage to the area and population of each country.

Reference numbers.	COUNTRIES.	MILEAGE OPEN ON DECEMBER 31					INCREASE BETWEEN 1900 AND 1904.		Area (square miles).	Thousands of inhabitants.	Mileage open at the end of 1904	
		1900	1901	1902	1903	1904	Total Col. 7 — col. 3.	Percentage Col. 8 X 100 Col. 3.			per 100 square miles.	per 10,000 inhabitants.
		3	4	5	6	7	8	9			12	13
1	2	3	4	5	6	7	8	9	10	11	12	13
	<b>I. — Europe.</b>	<b>MILES.</b>					<b>MILES.</b>	<b>P. C.</b>	<b>ROUND FIGURES.</b>			
	<b>Germany.</b>											
	Prussia . . . . .	19,139.2	19,677.9	20,173.2	20,414.9	20,822.5	1,683.3	8.8	134,600	34,473	15.5	6.0
	Bavaria . . . . .	4,192.5	4,209.2	4,245.3	4,400.0	4,603.8	411.3	9.8	29,300	6,176	15.7	7.5
	Saxony . . . . .	1,772.8	1,792.7	1,826.9	1,847.4	1,847.4	74.6	4.2	5,790	4,202	31.9	4.4
	Württemberg . . . . .	1,069.4	1,174.4	1,184.4	1,209.2	1,232.8	163.4	15.3	7,530	2,169	16.4	5.7
	Baden . . . . .	1,216.1	1,286.9	1,297.4	1,297.4	1,307.4	91.3	7.5	5,830	1,868	22.4	7.0
	Alsace-Lorraine . . . . .	1,131.5	1,175.0	1,175.0	1,184.4	1,223.5	92.0	8.1	5,600	1,719	21.8	7.1
	Other States . . . . .	3,412.0	3,436.9	3,466.0	3,466.0	3,469.1	77.1	2.3	20,120	5,760	17.3	6.1
	<b>Total for Germany . . . . .</b>	<b>31,933.5</b>	<b>32,753.0</b>	<b>33,368.2</b>	<b>33,819.3</b>	<b>34,526.5</b>	<b>2,593.0</b>	<b>8.1</b>	<b>208,770</b>	<b>56,367</b>	<b>16.5</b>	<b>6.1</b>
2	Austro-Hungary (inclusive of Bosnia and Herzegovina) . . . . .	22,918.5	23,296.9	23,638.0	24,120.8	24,338.3	1,419.8	6.2	261,210	47,118	9.3	5.2
3	Great Britain and Ireland . . . . .	21,864.0	23,035.5	22,158.5	22,461.7	22,554.3	690.3	3.2	121,240	41,450	18.6	5.4
4	France . . . . .	26,611.9	27,127.7	27,747.2	28,100.2	28,442.5	1,830.6	6.9	207,110	38,962	13.7	7.3
5	Russia in Europe and Finland (2,037.5 miles). . . . .	30,112.1	31,944.7	32,522.5	33,093.6	33,994.6	3,882.5	12.9	2,061,170	105,542	1.6	3.2
6	Italy . . . . .	9,809.8	9,824.0	9,906.1	9,966.4	10,014.8	205.0	2.1	110,660	32,475	9.1	3.1
7	Belgium . . . . .	3,942.7	4,024.0	4,119.1	4,237.2	4,375.2	432.5	11.0	11,390	6,694	38.4	6.5
8	Netherlands and Luxembourg . . . . .	1,994.0	2,023.9	2,057.4	2,095.3	2,133.2	139.2	7.0	13,750	5,341	15.5	4.0
9	Switzerland . . . . .	2,350.7	2,429.6	2,483.7	2,575.6	2,640.3	289.6	12.3	15,990	3,325	16.5	7.9
10	Spain . . . . .	8,299.8	8,469.4	8,556.4	8,606.8	8,782.6	482.8	5.8	191,860	17,961	4.6	4.9
11	Portugal . . . . .	1,476.4	1,483.9	1,482.7	1,493.8	1,549.7	73.3	5.0	35,750	5,429	4.3	2.9
12	Denmark . . . . .	1,864.8	1,905.8	1,929.4	1,963.0	2,043.1	178.3	9.6	14,870	2,449	13.7	8.3
13	Norway . . . . .	1,275.7	1,305.5	1,456.5	1,456.5	1,515.6	239.9	18.8	124,450	2,221	1.2	6.8
14	Sweden . . . . .	7,034.0	7,200.6	7,566.6	7,697.7	7,815.1	781.1	11.1	172,940	5,136	4.5	15.2
15	Servia . . . . .	359.1	359.1	359.1	359.1	359.1	...	...	18,650	2,494	1.9	1.4
16	Roumania . . . . .	1,925.0	1,970.4	1,974.1	1,974.1	1,974.1	49.1	2.5	50,700	5,913	3.9	3.3
17	Greece . . . . .	604.0	643.1	643.1	643.1	604.7	90.7	15.0	24,980	2,434	2.8	2.9
18	Turkey in Europe, Bulgaria and Rumelia . . . . .	1,952.4	1,952.4	1,952.4	1,952.4	1,952.4	...	...	103,090	9,824	1.9	2.0
19	Malta, Jersey, Isle of Man. . . . .	68.4	68.4	68.4	68.4	68.4	...	...	420	372	16.3	1.8
	<b>Total for Europe . . . . .</b>	<b>176,396.8</b>	<b>180,817.9</b>	<b>183,989.4</b>	<b>186,685.0</b>	<b>189,774.5</b>	<b>13,377.7</b>	<b>7.6</b>	<b>3,769,000</b>	<b>391,507</b>	<b>5.0</b>	<b>4.8</b>

Reference numbers.	COUNTRIES.	MILEAGE OPEN ON DECEMBER 31					INCREASE BETWEEN 1900 AND 1904		Area. (Square miles.)	Thousands of inhabitants.	Mileage open at the end of 1904	
		1900	1901	1902	1903	1904	Total Col. 7 - col. 3.	Percentage Col. 8 X 100 Col. 3.			per 100 square miles.	per 10,000 inhabitants.
		3	4	5	6	7	8	9			12	13
	<b>H. — America.</b>											
20	United States of America.	193,308·3	197,198·2	202,432·1	207,935·6	213,962·4	20,554·1	10·6	2,993,480	78,595	7·1	27·2
21	Canada.	17,831·8	18,290·4	18,863·9	19,074·0	19,607·1	1,775·3	9·9	3,385,470	5,339	0·6	36·7
22	Newfoundland.	641·3	655·6	655·6	655·6	657·4	16·1	2·5	42,780	214	1·5	30·7
23	Mexico.	9,055·4	9,602·8	10,357·2	10,357·2	12,077·8	3,022·4	33·4	778,410	14,545	1·6	8·3
24	Cent. America: Guatemala (400·2 miles), Honduras (57·2 mil.), Salvador (96·9 m.), Nicaragua (155·3 m.), Costa Rica (293·9 m.).	780·5	829·5	832·0	945·7	1,003·5	223·0	28·6	...	...	...	...
25	Greater Antilles (Cuba, 1,583·3 mil.; Rep. of Dominica, 116·8 m.; Haiti, 139·5 m.; Jamaica, 185·2 m.; Porto Rico, 200·1 m.).	1,557·2	1,557·2	1,685·2	2,161·8	2,225·2	668·0	42·9	...	...	...	...
26	Lesser Antilles (Martinique, 139·2 miles; Barbadoes, 57·8 miles; Trinity, 88·2 miles).	277·7	277·7	277·7	285·2	285·2	7·5	2·7	...	...	...	...
27	United States of Columbia.	400·2	400·2	400·2	400·2	410·7	10·5	2·6	513,840	4,500	0·08	0·9
28	Venezuela.	633·8	633·8	633·8	633·8	633·8	...	...	403,070	2,445	0·16	2·6
29	British Guiana.	54·7	74·6	74·6	75·8	75·8	21·1	38·6	88,650	295	0·09	2·6
30	Dutch Guiana.	...	...	...	...	37·3	37·3	...	...	...	...	...
31	Ecuador.	186·4	186·4	186·4	186·4	186·4	...	...	115,680	1,400	0·16	1·3
32	Peru.	1,035·8	1,035·8	1,035·8	1,035·8	1,145·8	110·0	10·6	439,010	4,607	0·26	2·5
33	Bolivia.	621·4	621·4	655·6	655·6	701·6	80·2	12·9	515,160	2,269	0·14	3·1
34	United States of Brazil.	9,195·2	9,195·2	9,195·2	9,368·0	10,406·3	1,211·1	13·2	3,223,470	14,934	0·3	7·0
35	Paraguay.	157·2	157·2	157·2	157·2	157·2	...	...	97,730	636	0·16	2·5
36	Uruguay.	1,144·0	1,144·0	1,210·5	1,210·5	1,210·5	66·5	5·8	69,000	931	1·8	13·0
37	Chili.	2,849·7	2,879·5	2,885·1	2,885·1	2,885·1	35·4	1·2	299,630	3,314	0·96	8·7
38	Argentine Republic.	10,171·4	10,418·7	10,418·7	10,797·7	12,409·6	2,238·2	22·0	1,114,180	4,894	1·1	25·4
	<b>Total for America.</b>	<b>249,902·0</b>	<b>255,158·2</b>	<b>261,956·8</b>	<b>268,821·2</b>	<b>279,978·7</b>	<b>30,076·7</b>	<b>12·0</b>	<b>...</b>	<b>...</b>	<b>...</b>	<b>...</b>
	<b>III. — Asia.</b>											
39	Central Russia in Asia.	1,658·4	1,658·4	1,658·4	1,658·4	1,658·4	...	...	214,260	7,740	0·8	2·1
40	Siberia and Manchuria.	3,852·5	5,664·5	5,664·5	5,664·5	5,664·5	1,812·0	47·0	4,833,590	5,773	0·12	9·8
41	China.	401·4	768·0	942·0	1,175·7	1,227·8	826·4	205·9	4,278,550	357,250	0·03	0·03
42	Corea.	26·1	26·1	37·3	37·3	535·6	509·5	1,952·4	84,400	9,670	0·63	0·6
43	Japan.	3,661·2	4,070·1	4,236·0	4,365·8	4,648·6	987·4	27·0	161,160	46,542	2·9	1·0
44	British India.	23,758·6	25,367·9	25,925·9	26,950·6	27,559·5	3,800·9	16·0	1,956,950	294,905	1·4	0·93
45	Ceylon.	297·0	297·0	368·5	391·5	391·5	94·5	31·8	24,670	3,687	1·6	1·1
46	Persia.	33·6	33·6	33·6	33·6	33·6	...	...	635,160	9,000	0·005	0·04
47	Asia Minor and Syria with Cyprus (36 miles).	1,715·0	1,715·0	1,715·0	2,008·9	2,152·5	437·5	25·5	686,590	19,568	0·3	1·1
48	Portuguese Indies.	51·0	51·0	51·0	51·0	51·0	...	...	1,430	572	3·6	0·9
49	Malay Archipelago (Borneo, Celebes, etc.).	272·8	272·8	272·8	400·2	446·8	174·0	63·8	33,280	719	1·3	6·2
50	Dutch Ind. (Java, Sumatra).	1,301·2	1,383·8	1,384·4	1,430·4	1,430·4	129·2	9·9	231,280	29,577	0·6	0·5
51	Siam.	203·2	237·4	331·8	425·6	446·2	243·0	119·6	244,410	9,000	0·18	0·5
52	Cochinchina, Cambaja, Annam, Tonkin (1,490·1 m.); Pondicherry (59 m.), Malacca (57·2 m.), Philippine Islands (121·8 m.).	238·0	268·4	1,728·1	1,728·1	1,728·1	1,490·1	626·1	...	...	...	...
	<b>Total for Asia.</b>	<b>37,470·0</b>	<b>41,814·0</b>	<b>44,349·3</b>	<b>46,321·6</b>	<b>47,974·5</b>	<b>10,504·5</b>	<b>28·0</b>	<b>...</b>	<b>...</b>	<b>...</b>	<b>...</b>

Reference numbers.	COUNTRIES.	MILEAGE OPEN ON DECEMBER 31					INCREASE BETWEEN 1900 AND 1904		Area. (Square miles.)	Thousands of inhabitants.	Mileage open at the end of 1904	
		1900	1901	1902	1903	1904	Total Col. 7 — col. 3.	Percentage Col. 8 X 100 Col. 3.			per 100 square miles.	per 10,000 inhabitants.
		3	4	5	6	7	8	9			12	13
	<b>IV. — Africa.</b>											
53	Egypt. . . . .	2,066.6	2,886.9	2,952.8	2,952.8	3,233.7	1,147.1	55.0	383,920	9,833	0.8	3.3
54	Algeria and Tunis . . . .	2,041.5	3,041.1	3,041.1	3,041.1	3,041.1	399.6	15.1	346,500	6,895	0.9	4.5
55	Congo Free State . . . .	275.9	275.9	275.9	275.9	297.1	21.2	7.7	...	...	...	...
56	Abyssinia . . . . .	...	...	183.9	233.7	233.7	233.7	...	...	...	...	...
57	British South Africa. { Cape Colony . . . . .	2,937.3	2,937.3	2,982.0	3,510.8	3,510.8	573.5	19.5	303,800	1,766	1.2	19.9
	{ Natal . . . . .	736.3	736.3	736.3	736.3	736.3	...	...	27,380	778	2.7	9.5
	{ Transvaal . . . . .	1,202.4	1,202.4	1,202.4	1,334.7	1,334.7	132.3	11.0	119,160	867.9	1.1	15.4
	{ Orange Colony. . . . .	596.5	596.5	596.5	596.5	596.5	...	...	50,620	208	1.2	28.7
	Colonies :											
58	Germany (German East Africa, 80.8 miles; German South West Africa, 443 miles; Togo, 25 miles) . . . . .	186.4	292.0	292.0	292.0	551.8	365.4	196.0	...	...	...	...
59	England (British East Africa, 531.6 m.; Sierra Leone, 225.5 m.; Gold Coast, 167.8 m.; Lagos, 126.8 miles; Mauritius, 116.8 miles) . . . . .	549.3	835.4	933.9	1,167.6	1,218.5	669.2	121.8	...	...	...	...
60	France (French Soudan, 523.8 m.; French Somali Coast, 99.4 m.; Madagascar, 82 m.; Reunion, 78.9 miles) . . . .	683.5	720.8	720.8	784.1	784.1	100.6	14.7	...	...	...	...
61	Italy (Erythrea, 47.2 m.) .	16.8	16.8	16.8	16.8	47.2	30.4	181.5	...	...	...	...
62	Portugal (Angola, 337.4 m.; Mozambique, 279 m.) .	586.0	586.0	616.4	616.4	616.4	30.4	5.2	...	...	...	...
	<b>Total for Africa. . . . .</b>	<b>12,498.5</b>	<b>14,187.4</b>	<b>14,550.8</b>	<b>15,558.7</b>	<b>16,201.9</b>	<b>3,703.4</b>	<b>29.6</b>	<b>...</b>	<b>...</b>	<b>...</b>	<b>...</b>
	<b>V. — Australia.</b>											
63	New Zealand . . . . .	2,780.5	2,340.8	2,340.8	2,403.5	2,440.8	160.3	7.0	104,640	830	2.3	29.4
64	Victoria . . . . .	3,217.5	3,236.8	3,302.0	3,382.8	3,382.8	165.3	5.1	88,420	1,201	3.8	28.2
65	New South Wales. . . . .	2,810.5	2,814.7	3,024.9	3,138.0	3,240.3	469.8	16.7	308,550	1,370	1.1	73.9
66	South Australia . . . . .	1,882.1	1,882.1	1,882.1	1,900.8	1,900.8	18.7	1.0	904,130	363	0.2	52.4
67	Queensland. . . . .	2,800.6	2,800.6	2,800.6	2,927.3	2,927.3	126.7	4.5	698,520	485	0.4	60.4
68	Tasmania . . . . .	479.1	479.1	618.9	620.2	620.2	141.1	29.3	28,220	172	2.4	36.1
69	West Australia . . . . .	1,363.3	1,977.2	1,977.2	2,144.4	2,169.3	806.0	59.1	975,830	412	0.2	52.7
70	Hawai (24.9 miles) with the isles Maui (6.8 miles) and Oahu (56.5 miles) . .	88.2	88.2	88.2	88.2	88.2	...	...	6,830	109	1.3	8.1
	<b>Total for Australia . . . .</b>	<b>14,921.8</b>	<b>15,649.5</b>	<b>16,034.7</b>	<b>16,605.2</b>	<b>16,809.7</b>	<b>1,857.9</b>	<b>12.6</b>	<b>3,083,140</b>	<b>4,942</b>	<b>0.5</b>	<b>34.0</b>
	<b>Repopulation.</b>											
I	Europe . . . . .	176,396.8	180,817.0	183,989.4	186,685.0	189,774.5	13,377.7	7.6	3,760,000	391,507	5.0	4.8
II	America . . . . .	249,002.0	255,158.2	261,956.8	268,821.2	279,978.7	30,076.7	12.0	...	...	...	...
III	Asia . . . . .	37,470.0	41,814.0	44,349.3	46,321.6	47,974.5	10,504.5	28.0	...	...	...	...
IV	Africa . . . . .	12,498.5	14,187.4	14,550.8	15,558.7	16,201.9	3,703.4	29.6	...	...	...	...
V	Australia . . . . .	14,921.8	15,649.5	16,034.7	16,605.2	16,809.7	1,857.9	12.6	3,083,140	4,942	0.5	34.0
	<b>Total for the whole world.</b>	<b>491,189.1</b>	<b>507,627.0</b>	<b>520,881.0</b>	<b>533,991.7</b>	<b>550,739.3</b>	<b>59,550.2</b>	<b>12.1</b>	<b>...</b>	<b>...</b>	<b>...</b>	<b>...</b>
	<b>Percentage of increase on the preceding year . . .</b>	<b>2.2</b>	<b>3.4</b>	<b>2.6</b>	<b>...</b>	<b>...</b>	<b>...</b>	<b>...</b>	<b>...</b>	<b>...</b>	<b>...</b>	<b>...</b>

**Table II.**

*Construction cost of the railways in different countries.*

Reference number.	COUNTRIES AND RAILWAY SYSTEMS.	Time	Mileage	Construction capital			
		to which the data as to the cost apply.		total.	per kilometre.	per mile.	
	<b>I. — Europe.</b>		Miles.	Marks (round millions).	£	Marks.	£
1	Germany :						
	The entire system . . . . .	1904	33,504	14,011,000,000	700,550,000	262,284	21,105
2	Austro-Hungary :						
	Austria : The entire system . . .	1901	17,813	5,771,000,000	288,550,000	279,655	22,519
	Hungary : The entire system . . .	Dec. 31, 1903	11,005	2,910,000,000	145,560,000	164,165	13,210
3	Belgium :						
	Belgian State . . . . .	1903	2,520	1,679,000,000	83,950,000	418,274	33,657
4	France . . . . .	1902	27,740	14,162,000,000	708,160,000	317,229	25,526
5	Switzerland :						
	The entire system . . . . .	1903	2,536	1,082,000,000	54,100,000	266,711	21,461
6	Great Britain and Ireland :						
	The entire system . . . . .	1902	22,148	24,337,000,000	1,216,850,000	682,805	54,942
7	Russia (without Finland) :						
	The entire system . . . . .	1902	36,694	11,638,000,000	581,900,000	197,126	15,862
	Finland : State railways . . . . .	1902	1,678	224,000,000	11,200,000	81,609	6,566
8	Norway :						
	The entire system . . . . .	1903-1904	1,318	225,000,000	11,250,000	106,060	8,534
9	Sweden :						
	State railways . . . . .	1903	2,554	471,000,000	23,550,000	114,519	9,215
	Private companies . . . . .	1903	4,817	445,000,000	22,250,000	57,392	4,618
10	Italy :						
	The entire system . . . . .	1902	9,961	4,529,000,000	226,450,000	282,540	22,735
11	Roumania :						
	The entire system . . . . .	1903-1904	1,975	716,000,000	35,800,000	225,173	18,119
12	Servia :						
	State railways . . . . .	1903	336	100,000,000	5,000,000	185,193	14,902
13	Bulgaria :						
	State railways . . . . .	1903	751	122,000,000	6,100,000	101,042	8,130
14	Spain :						
	Northern railway . . . . .	1900	2,272	900,000,000	45,000,000	246,098	19,802
15	Netherlands :						
	The entire system . . . . .	1897	1,653	574,000,000	28,700,000	215,614	17,350
16	Denmark :						
	State railways . . . . .	1903-1904	1,139	215,000,000	10,750,000	117,214	9,432
	Total and average . . . . .	...	177,494	84,111,000,000	4,205,550,000	294,461	23,604

Reference number.	COUNTRIES AND RAILWAYS SYSTEMS.	Time	Mileage	Construction capital			
		to which the data as to the cost apply.		total.	per kilometre.	per mile.	
	Other parts of the globe.		Miles.	Marks (round millions).	£	Marks.	£
1	United States of America . . . . .	June 30, 1904	213,862	55,495,000,000	2,774,750,000	167,752	13,498
2	Canada . . . . .	— 30, 1904	19,607	4,983,000,000	249,150,000	157,934	12,708
3	Uruguay. . . . .	1898-1899	997	221,000,000	11,050,000	137,816	11,089
4	Chili : State railways . . . . .	December 31, 1898	1,375	316,000,000	15,800,000	140,454	11,302
5	Argentine Republic . . . . .	1902	10,798	2,272,000,000	113,600,000	130,736	10,520
6	British India . . . . .	December 31, 1904	27,560	4,730,000,000	236,500,000	106,654	8,582
7	Japan. . . . .	March 31, 1904	4,494	769,000,000	38,450,000	106,580	8,576
8	Siam . . . . .	1904-1905	190	22,000,000	1,100,000	72,898	5,866
9	Java . . . . .	1893	607	124,000,000	6,200,000	135,718	10,921
10	Algiers and Tunis . . . . .	December 31, 1902	2,270	546,000,000	27,300,000	147,433	11,863
11	Cape Colony . . . . .	— 31, 1904	2,561	544,000,000	27,200,000	131,884	10,612
12	Natal . . . . .	— 31, 1902	635	189,000,000	9,450,000	185,070	14,892
13	Sierra-Leone . . . . .	1903	222	20,000,000	1,000,000	53,600	4,313
14	Gold Coast. . . . .	1903	170	36,000,000	1,800,000	128,000	10,300
15	Lagos. . . . .	1903	125	18,000,000	900,000	88,000	7,081
16	Colony of New Zealand . . . . .	March 31, 1904	2,328	422,000,000	21,100,000	113,816	9,158
17	— of Victoria . . . . .	June 30, 1904	3,383	841,000,000	42,060,000	154,566	12,437
18	— of New South Wales . . . . .	— 30, 1904	3,280	863,000,000	43,150,000	163,428	13,150
19	— of South Australia . . . . .	— 30, 1904	1,736	276,000,000	13,800,000	98,703	7,942
20	— of Queensland . . . . .	— 30, 1904	2,927	426,000,000	21,300,000	90,450	7,278
21	— of Tasmania . . . . .	December 31, 1903	462	79,000,000	3,950,000	106,640	8,581
22	— of Western Australia . . . . .	June 30, 1904	1,541	183,000,000	9,150,000	73,967	5,952
	Total and average. . . . .	...	301,130	73,375,000,000	3,668,750,000	151,409	12,183

[ 624 .152.8 ]

## 2. — Union Pacific motor car No. 7.

Fig. 1, p. 1473.

(*The Railway Age*.)

Supplementing the description of Union Pacific motor car No. 7 published in *The Railway Age* of April 13, some further information as to construction and service furnished by the courtesy of Mr. W. R. McKeen, Jr., superintendent of motive power and machinery, is given herewith.

This car is of the same general design as those that have preceded it, and which are in successful service in various parts of the country; there are, however, some new features which are shown in the accompanying engravings. As shown in the previous article, the car is furnished with side entrance. The door apertures are worked into the side of the car without weakening, by means of patented steel framing, incorporating an uninterrupted depressed side sill. By the slightly increased thickness of side plates and the additional strength secured in this framing, a great increase in the strength of car is obtained. The roof is 9 inches lower than in the previous motor cars, and yet the ventilation is said to be equally good.

The square design of window has been done away with, and air, water and dust proof round window sash has been substituted. The appearance is similar to that of the porthole of a vessel, and the arrangement keeps out all the elements, which is almost impossible, even with the double sash of the finest Pullman cars. By the use of round windows and the elimination of large wooden posts, a gain of 8 inches is made in the interior dimensions of this car.

The car embraces all the latest developments and improvements in motor car construction, among which is the cast steel engine bed truck frame combination casting, called a "skirk," which is a large factor in developing the practical side of the motor car in everyday service. The power is transmitted from the crankshaft by use of chain, cast steel gears being used for putting the car in motion. There are only two speeds — one with gear running car up to 10 miles an hour, which is by means of an "octoroon" clutch, which may be thrown out of mesh and the engine

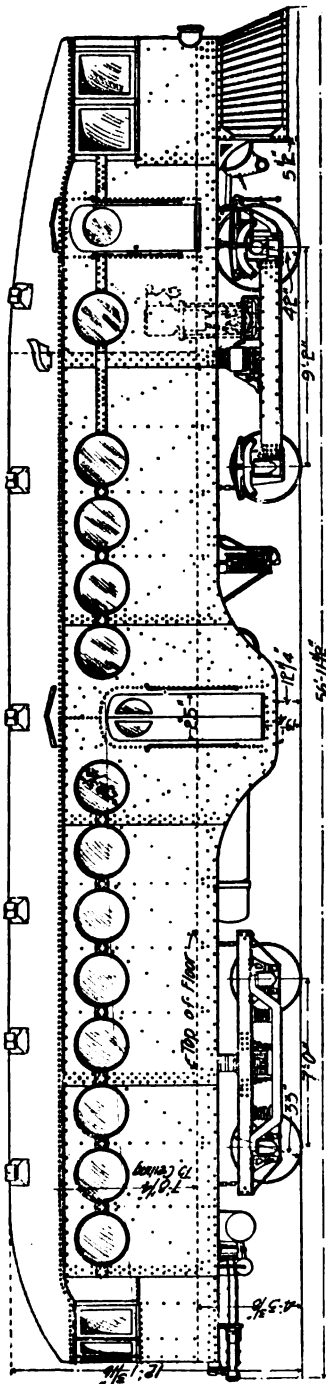


Fig. 1. — Union Pacific motor car No. 7. — Elevation showing structural details.

connected up direct with the driving axle. Air pressure is used for starting the engine, for whistle signals, for operating the clutch mechanism and air brake. An auxiliary air pump has been applied, for emergency in case of any shortage of air, which ordinary is supplied by a small air pump, driven from the main engine crank shaft.

Car No. 7 has built up veneered wood seats, with a semicircular seat at rear, as in the other cars. The seating capacity is 75. The interior is finished in English oak. The total weight is 58,000 pounds and the length 55 feet.

The gearing is arranged for a speed of 50 miles an hour, and in preliminary tests around Omaha and vicinity this speed has been attained. After running around the Omaha yards and vicinity for the purpose of limbering up machinery, etc., the car was given its first long distance trial April 14 and 15. On April 14 it left Omaha as the second section of train No. 1, the Overland Limited. The motor car gained on No. 1 to such an extent that at Fremont, 46 miles from Omaha, the motor car was held on the block six minutes. Owing to a heavy wind and meeting trains from this point on, some time was lost on No. 1's schedule. However, the total time of the motor car from Omaha to Grand Island was 5 hours and 12 minutes, with a delay of 40 minutes on account of orders, meeting trains etc., the actual running time for the 153.6 miles being 4 hours 32 minutes, or 34 miles per hour. There was no delay whatever on account of the motor car, and the machinery was in almost constant motion from Omaha to Grand Island.

On the return trip on April 15 a speed run was not attempted, and the car was delayed over three hours for orders, meets, etc., in addition to a slight delay on account of a hot bearing. The actual running time from Grand Island to Omaha was 4 hours and 10 minutes, or 36.3 miles per hour. The run from Elkhorn to South Omaha, 24.3 miles, was covered in 36 minutes, or at the rate of 42 miles per hour. A maximum speed of 53 miles per hour was attained on this trip.

---

[ 625 .241 ]

### 3. — 200,000 lb. capacity flat car.

Figs. 2 to 6, pp. 1477 and 1478.

(*American Engineer and Railroad Journal.*)

The desire to ship heavy castings and parts of large engines which often individually weigh more than 100,000 lb. led the Allis-Chalmers Company, of Milwaukee, to request the mechanical department of the Chicago, Milwaukee & St. Paul Railway to design for them some flat cars capable of carrying 220,000 lb. This work was turned over to Mr. James F. De Voy, mechanical engineer, who, in connection with Mr. A. E. Manchester, superintendent of motive power, and Mr. J. J. Hennessey, master car builder, has designed the car shown in the illustrations herewith, two of which have been built at the West Milwaukee shops of the road.

In the original discussion of the general features of the design, it was decided that the car should have standard M. C. B. parts as far as possible, so that it could be easily repaired anywhere in the United States. This was particularly desirable in connection with wheels, axles, journal boxes and truck parts. Following up that idea, it was decided to use two 100,000 lb. standard trucks under each end of the car, these to be connected by a heavy cradle, in the centre of which would be the bearing for the car body, and under which the trucks would have free movement.

This cradle connecting the two trucks consists of two short but very strong and carefully

designed bolsters resting upon the truck bolster, which are connected by two heavy cast-steel side bars, in the centre of which is a cast-steel bolster on which the car body rests. This design is shown very clearly in the illustrations and its remarkable simplicity and strength are apparent. The bolsters resting over the trucks are broad and the truck centre bearing is located as high as possible, the strength being obtained by the deep flanges extending down on either side of the truck bolster. The side bars, which are 5 inches square at the ends where they connect to end castings, are gradually made deeper and narrower until they measure 4 inches thick and 14 inches deep at the centre, the top at the centre being depressed 2 inches for a distance to accommodate the centre castings. This centre casting is of steel and made deep and heavy, as it has to support a weight of 100,000 lb. besides half of the car body. The lips passing over the side rails are extended beyond and form a bearing for the side bearings. The centre plate, which is cast integral with the bolster, is sunk down as low as possible, its bearing surface being 4 inches below the level of the side rail. This cradle spaces the trucks at 8 ft. 9 in. centres, giving them room to curve freely. The bolsters over the trucks are given very slight side clearance, so that the rocking tendency at this point is very small.

The car body, which measures 40 feet over end sills, is of simple but very strong design, and consists essentially of four 15-inch 100 lb. I-beams running continuously from end sill to end sill, the two forming the centre sills being spaced 12  $\frac{7}{8}$  inches between webs and the two side sills at 8-foot centres. The centre sills are located 1 inch lower than the side sills. These are connected at the ends by 15-inch 55 lb. channels with the flanges outward, which are fastened to the sills with very heavy corner irons securely riveted. For adding stiffness and strength at the corners, there are  $\frac{1}{2}$  by 18-inch gusset plates across the corners, and 1 by 8-inch diagonal braces from the end sill to the centre sill. At ten equally distant points there are 8-inch 21  $\frac{1}{4}$ -lb. channel irons fitted between the centre and side sills and securely fastened to both by angle irons in the corners. At these points 1 by 8-inch flanged plates are fitted between the centre sills. These cross channels are located with their upper flanges 4 inches below the top flange of the side sill and six 4 by 4-inch wooden nailing strips running from end sill to end sill are fastened to them and the floor of 2  $\frac{1}{2}$ -inch wood is nailed to these strips.

Because of the height of this car, which is 4 ft. 4  $\frac{1}{2}$  in. from top of floor to rail, it was necessary to cut out but a small section of the bottom of the end sill for the coupler shank to pass through, and at this point a heavy ribbed malleable casting acting as a stiffener has been fitted. On the outer end of each end still, are also heavy malleable iron push pocket plates.

The car bolster, which is located 8 ft. 9 in. from the inside of the end sill, consists, as is clearly shown in the cross-section of the car, of a very heavy trussed steel plate design. Extending across the top of the two centre sills and flanged downward and riveted to the inside of the web of the side sills are two 1 by 10 inch plates spaced 12 inches apart. Passing below the centre sills and extending upwards to the connection of these cover plates at the side sills, at which point it is flanged down and securely riveted to both, are two 1  $\frac{1}{2}$  by 10 inch plates. Diagonals are carried from the bottom of the side sills and from the top of the centre sills to these heavy trusses. The centre plate of heavy cast steel fits and is fastened to the bottom of the centre sills and the bolster trusses, as is clearly shown in the cross sections. The side bearings are simple castings fastened to the body bolster and bearing on the extension of the centre truck bolster mentioned above.

One of these cars has been tested for curving and it was found that it would take a 16-degree curve without trouble. It is believed that they will take any curve over which other cars are operated.

We are indebted to Mr. James F. De Voy, mechanical engineer of the Chicago, Milwaukee & St. Paul Railway for the drawings and photographs shown herewith.

[ 628 .242 ]

#### 4. — 30-ton ironstone wagon; North-Eastern Railway.

Figs. 7 to 12, pp. 1479 to 1482.

(*The Railway Engineer.*)

We are indebted to Mr. Wilson Worsdell, M. Inst. C. E., chief mechanical engineer of the North-Eastern Railway, for the accompanying drawings of the 30-ton hopper wagons which he has recently designed especially for carrying ironstone. The general dimensions of these wagons are the same as those of the North-Eastern standard 23 ton coal wagons, but on account of the heavier load carried and the low tare weight, the details of the construction are of particular interest.

The four-wheeled high capacity wagon has several advantages, especially in this country, but we do not think any one has ever gone so far in this direction before. The tare weight is 11 tons 18 cwt.; the net weight or paying load 30 tons, or 2.52 times the tare, and the gross weight 41 tons 18 cwt., or 3.52 times the tare, or in other words the tare weight is 39.7 per cent of the net weight and 28.4 per cent of the gross weight. These figures reflect the great credit on the design, especially as the wagons are fully equipped with the rapid-acting vacuum brake as well as hand brake levers on both sides.

Axle loads of 20.95 tons, separated by lengths of 10 ft. 6 in. and 12 ft. 6 in., have not hitherto, we think, been used in this country in regular ordinary traffic, except perhaps with locomotives when, the axles being nearer together, the load is more concentrated. But as the permanent way of our principal lines is constructed and maintained to support very heavy axle loads travelling at the high speeds, it is not likely to be seriously affected by the axle loads of these wagons at the speed at which they travel. On the branch lines, the permanent way is weaker, but the speeds are lower, and it is well known that in America, very heavy axle loads are continuously and safely passed at low speeds over much lighter and weaker permanent way than is to be found on any of our branch lines.

These wagons are used for the iron-ore traffic of the Cleveland district, the economical working of which is a matter of the first importance to the North-Eastern Railway. A considerable number of them have lately been built at the company's new wagon works at Shildon, near Darlington. They are constructed almost entirely of steel. The bottoms of the hoppers consist of four doors, so that the wagons will discharge themselves almost as fast as the doors can be opened.

The principal dimensions and scantlings are as under :

Length over the buffers, 23 feet; length of wheel base, 10 ft. 6 in.; length over the headstocks, 20 feet;

Width between the longitudinals, 4 ft. 2  $\frac{1}{2}$  in.; between the sole bars, 6 ft. 2 in.; between the centres of springs and centres of journals, 6 ft. 7  $\frac{1}{8}$  in.;

Body, at the top, inside 19 ft. 11  $\frac{1}{2}$  in. long by 7 ft. 6  $\frac{1}{2}$  in. wide by 5 ft. 6  $\frac{3}{4}$  in. deep; over the curb angle, 20 ft. 5 in. by 8 feet; at the bottom of hopper, 9 ft. 5  $\frac{1}{2}$  in. by 4 ft. 2  $\frac{1}{2}$  in.;

Figs. 2 to 6. — 100-ton (200,000 lb.) capacity flat car.

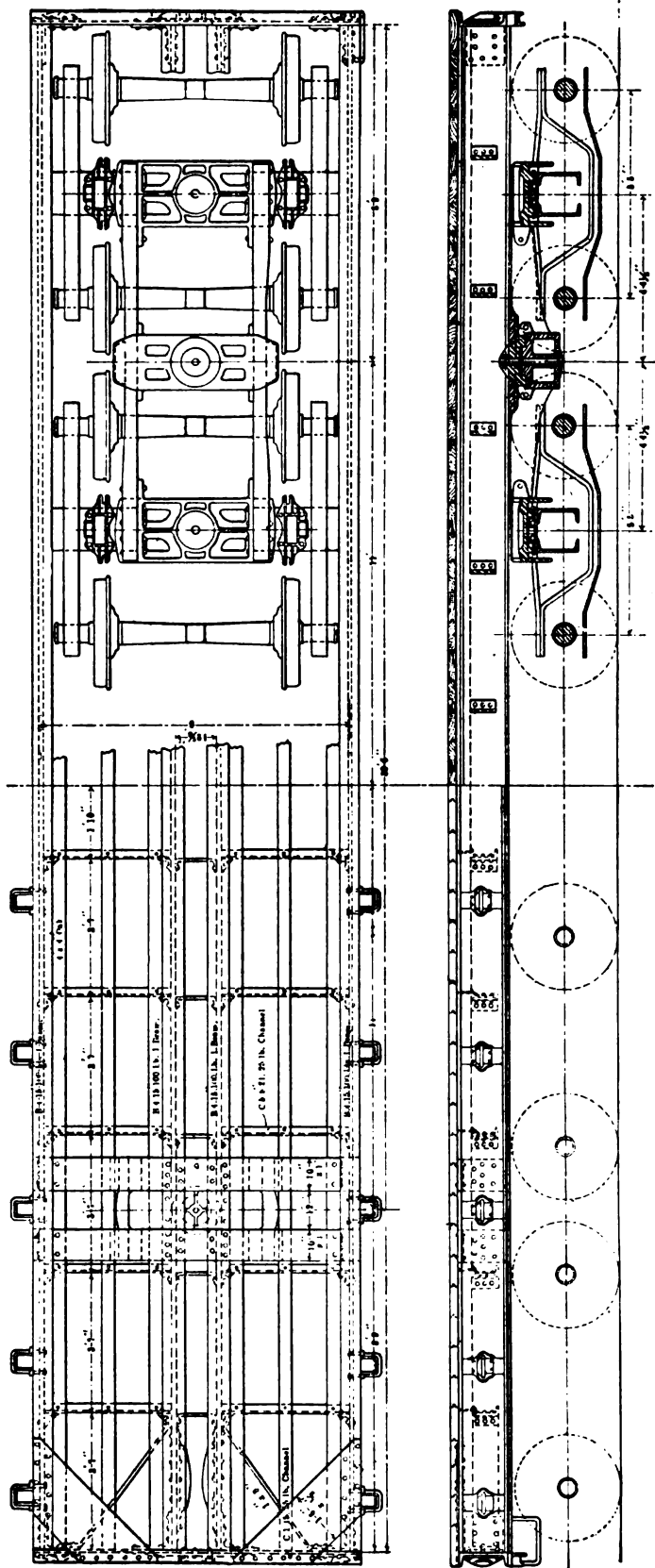


Fig. 2. — Plan and side elevations.

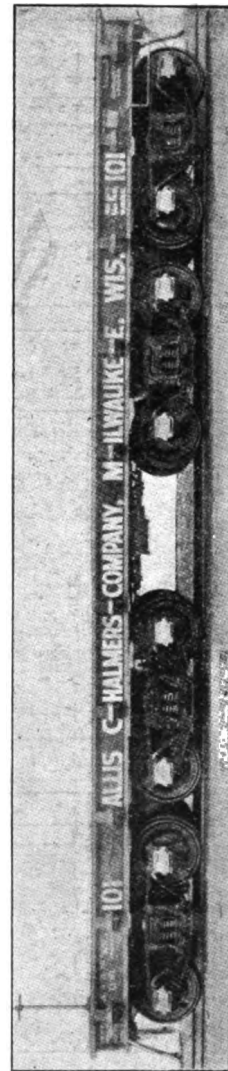


Fig. 3. — 100-ton (200,000 lb.) capacity flat car. — Allis-Chalmers Co.

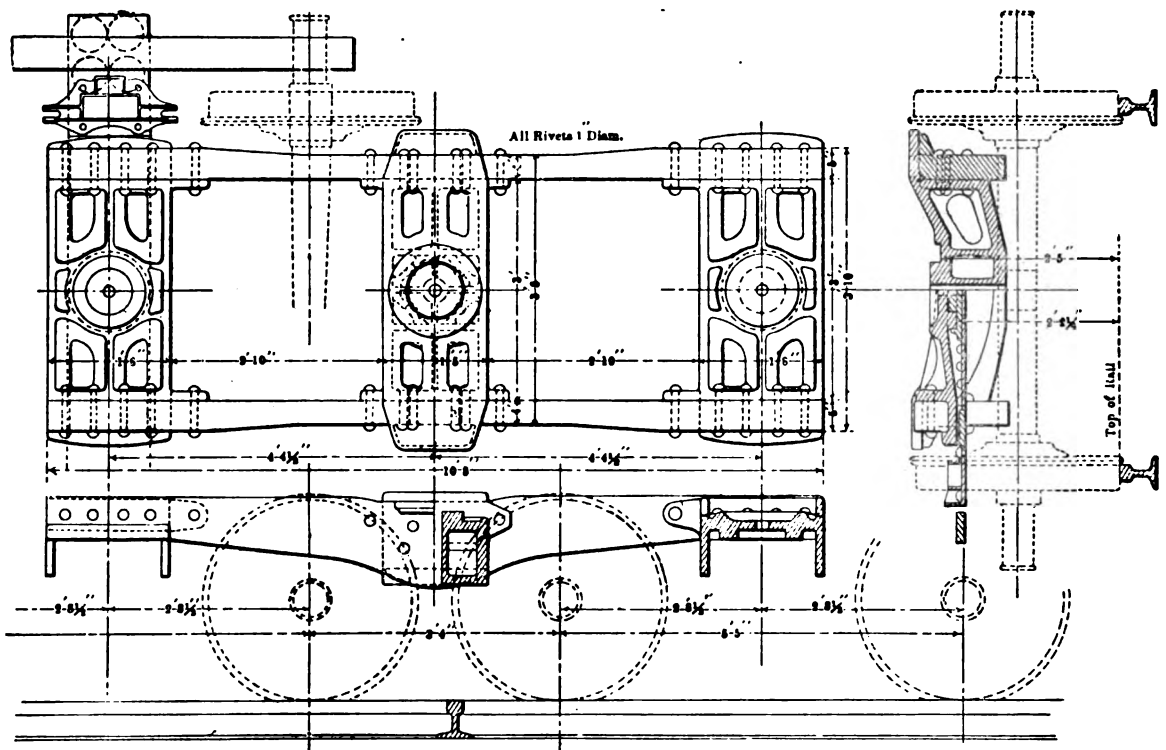


Fig. 4. — Sections, elevations and plan of cradle.

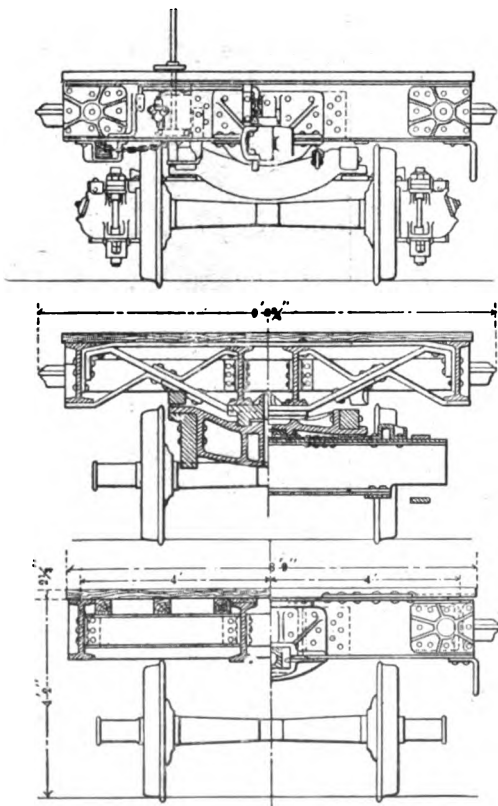


Fig. 5. - Sections and end elevation.

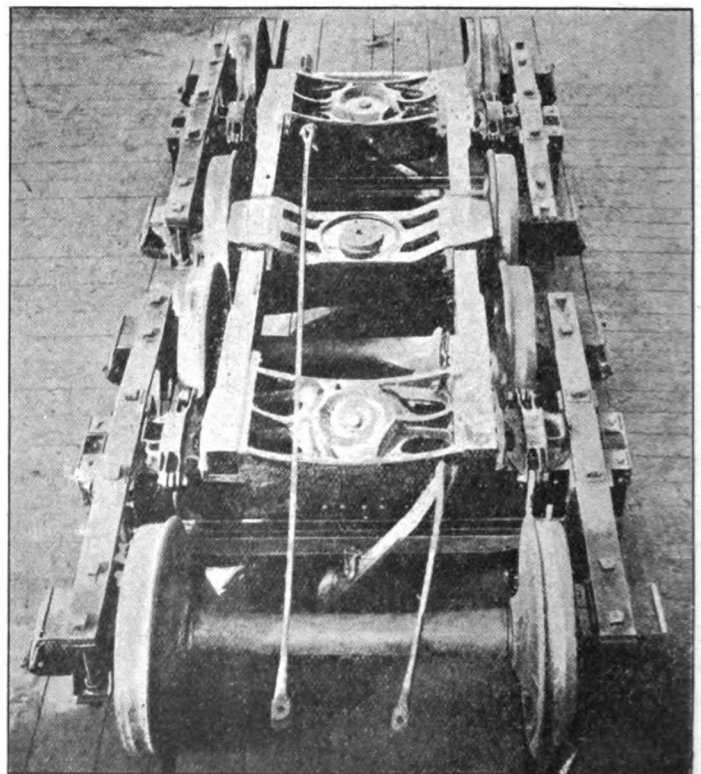
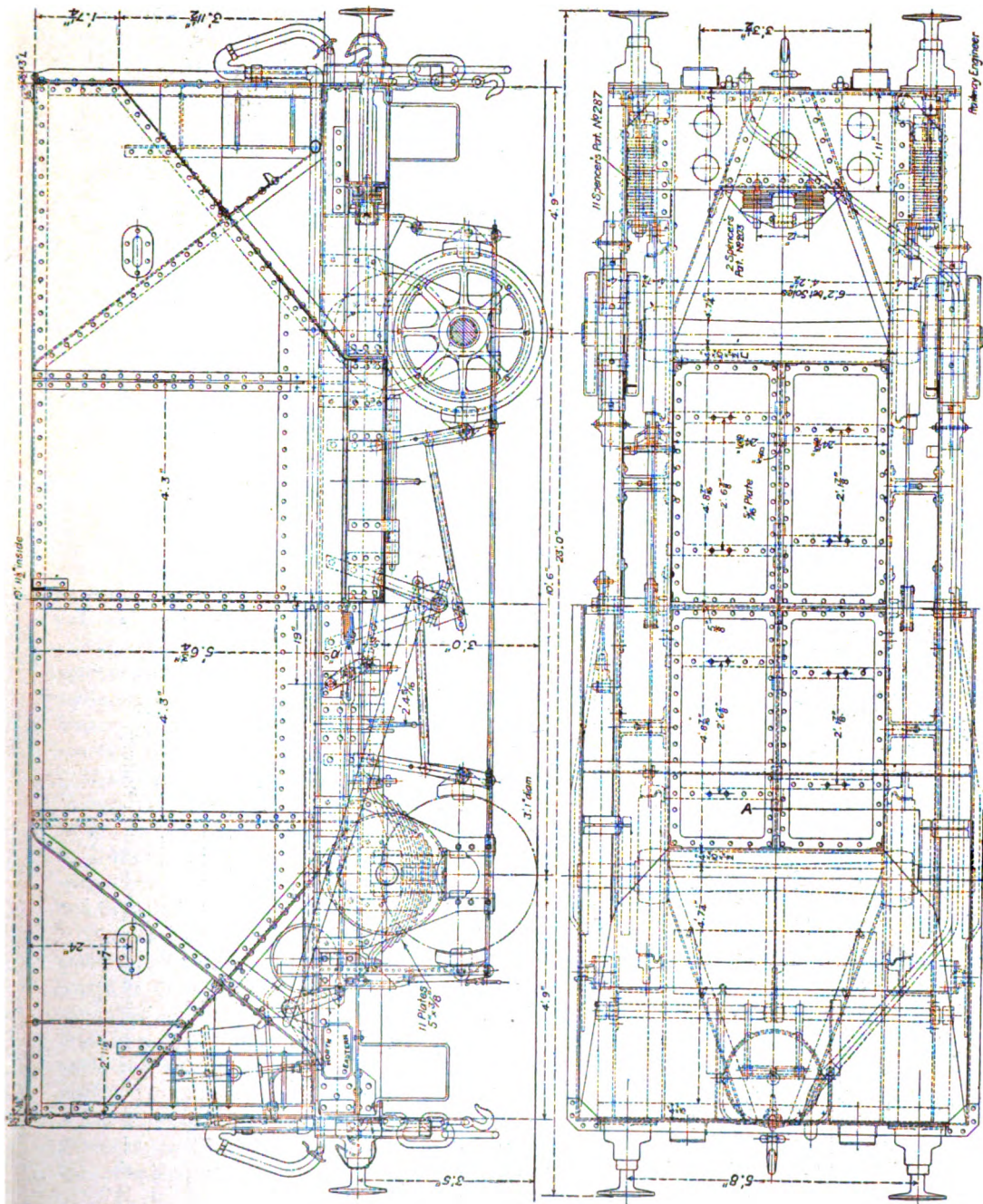


Fig. 6. — View of trucks and cradle.



**Figs. 7 and 8. — 30-ton ironstone wagon; North-Eastern Railway.**

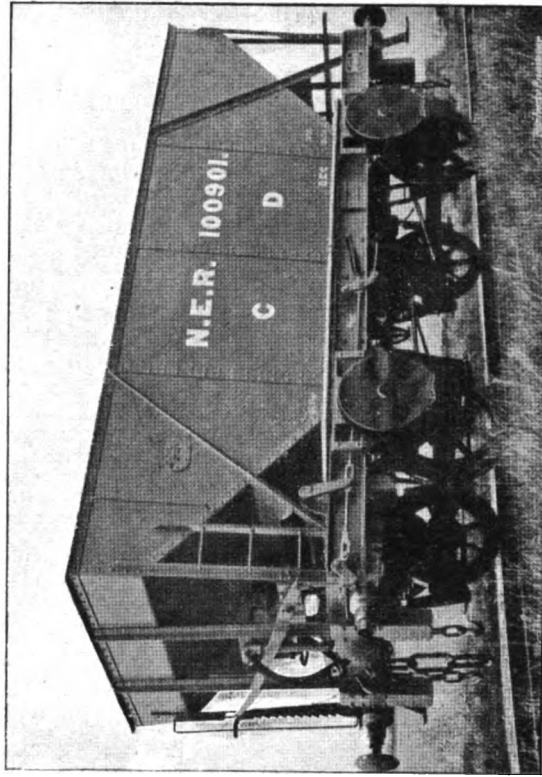
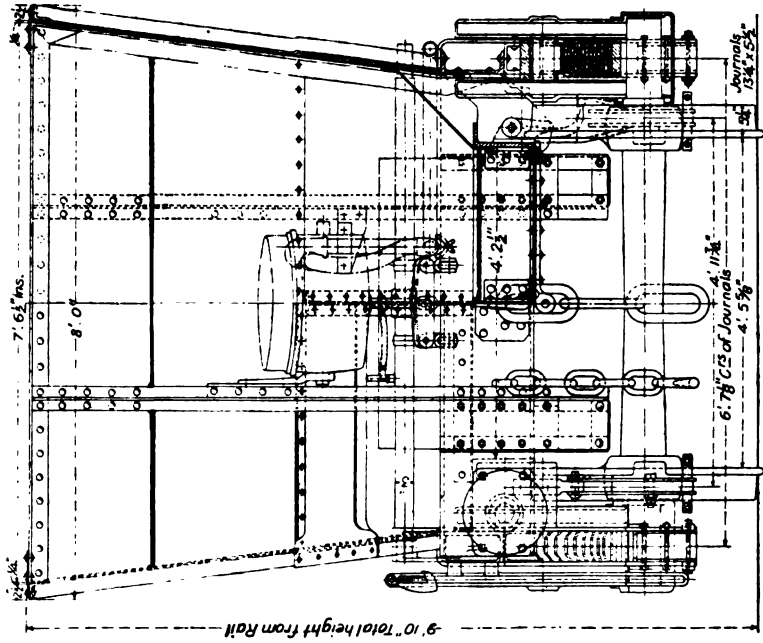


Fig. 10. — 30-ton ironstone wagon; North-Eastern Railway.



End elevation.

Section at A.

Fig. 9. — 30-ton ironstone wagon; North-Eastern Railway.

Bottom doors (4), each 4 ft. 8  $\frac{7}{16}$  in. by 2 ft.  $\frac{15}{16}$  in.; total area about 39 square feet  
Height of top of body above rails, 9 ft. 10 in.;  
Headstocks, 15 by 4 inches by  $\frac{11}{16}$  inch channel;  
Sole bars and cross bearers, 10 by 4 inches by  $\frac{1}{2}$  inch channel;  
Longitudinals, 10 by 4 inches by  $\frac{11}{16}$  inch angle;  
Central cross bearer and central longitudinal, 10 inches by  $\frac{5}{8}$  inch and 2 inches bulb;  
Diagonals, 3 by 3 inches by  $\frac{3}{8}$  inch angle;  
Sides and ends,  $\frac{1}{4}$  inch plate; bottom doors,  $\frac{5}{16}$  inch plate;  
Curb-angle, 3 by 2  $\frac{1}{2}$  inches by  $\frac{3}{8}$  inch;  
Body stiffeners and end stanchions, 4 by 3 inches by  $\frac{3}{8}$  tee;  
Body joint covers 4 inches by  $\frac{1}{4}$  inch, strip;  
Rivets,  $\frac{3}{4}$  inch diameter, pitched about 4 inches;  
Wheels, 3 ft 1 in. diameter, cast steel centres, with 8 spokes; retaining rings fastened with 8 rivets; tyres, 5  $\frac{1}{4}$  inches wide by 3 inches thick;  
Axles, journals 5  $\frac{1}{2}$  inches diameter by 13  $\frac{1}{4}$  inches long; wheel seat, 7 by 7 inches diameter at middle, 6  $\frac{1}{4}$  inches, centre to centre of journals, 6 ft. 7  $\frac{1}{8}$  in.; between the tyres, 4 ft. 5  $\frac{5}{8}$  in.;  
Bearing springs, 11 plates 5 inches by  $\frac{5}{8}$  inch; span unloaded, 3 ft. 6 in.

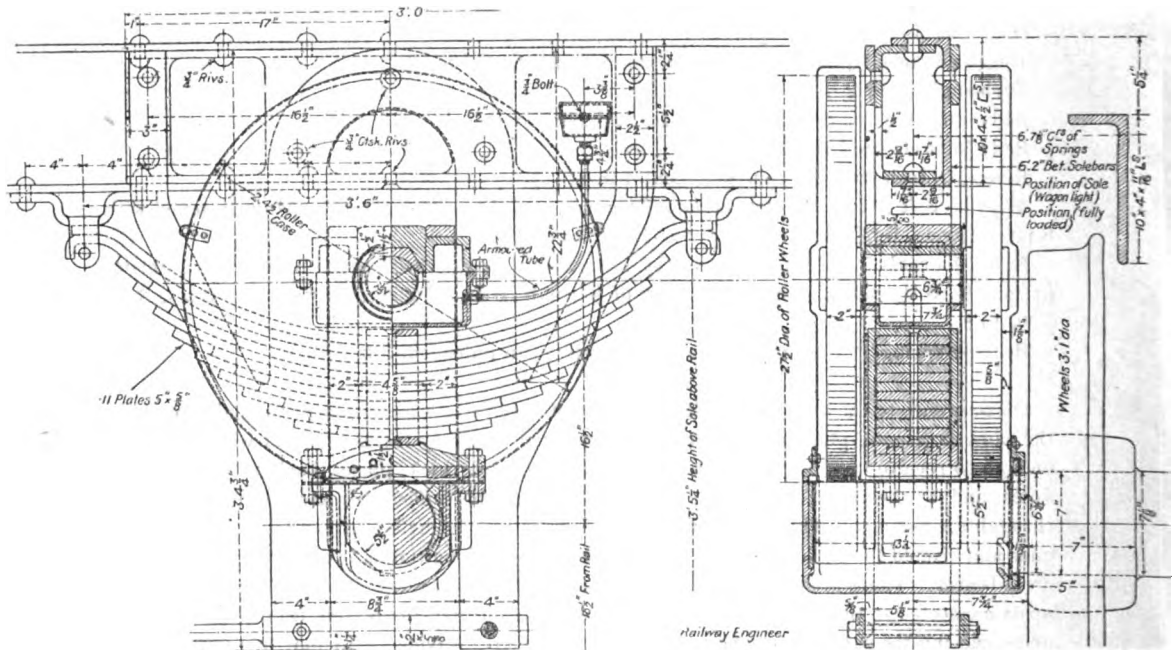
On reference to the drawings, it will be seen that the sole bars and the longitudinals are not on the same horizontal plane. They are connected at the ends by the headstocks which are deep enough to receive them and by pairs of bent plates  $\frac{5}{8}$  inch thick, placed back to back 2 inches apart, and by the bent plates which carry the ends of the buffer rods and receive the buffing through the springs. The end of the underframe is covered by a  $\frac{5}{16}$  inch plate flanged at the ends and riveted to the sole bars; it is also riveted to the longitudinals, diagonals, and drawbar cross bearer. There are two principal cross bearers of channel section back to back 9 ft. 5  $\frac{1}{2}$  in. apart connected to the longitudinals with angles, thus forming the bottom frame of the hopper and enclosing the space for the bottom doors, and which is divided into four by a central cross bearer and a central longitudinal, to which the doors are hinged, of bulb section connected at the centre with angles, as shown on the drawing.

The doors are of plates riveted to the underside of frames welded up solid out of 2  $\frac{1}{2}$  inches by  $\frac{1}{2}$  inch iron and are further strengthened by the hinge bars — made in one piece for each door — being riveted to their lower side. The hinge bars have projections which rest on pawls keyed on shafts carried on brackets off the longitudinals and controlled by “monkey-tail” levers, which work between the pairs of flanged plates (before mentioned), connecting the longitudinals and the sole bars, and are secured with cross pins.

The side plates are riveted to the sole bars and stiffened and joined with three Ts on the inside and covering strips on the outside. The ends are stiffened with two similar Ts and also supported by Ts from the headstocks, by a flanged plate, which is riveted to the end plates and to the angles tying the end from the curb angle to the sole bars, and by longitudinal plates  $\frac{3}{8}$  inch thick from the end stanchions to the end stiffening Ts. The top of the body is stiffened with an angle curb and the sides are tied together with a similar section, 2  $\frac{1}{2}$  by 3 inches by  $\frac{3}{8}$  inch, angle.

The drawbar pull is taken direct on to a channel cross bearer 10 by 4 inches by  $\frac{1}{2}$  inch, riveted to the diagonals through a pair of Spencer's compound india-rubber springs, the drawbar being attached to a cast steel washer, as shown.

The buffers are Compound, Spencer's patent, and are fitted with Spencer's patent india-rubber springs. They have a total stroke of 5' 2 inches, the last inch of which is taken up by a concentric plunger in the external buffer case, thus cushioning the final blow upon the headstock by means of patent plunger springs of 9 1/2 inches diameter within the enlarged part of the case.



**Figs. 11 and 12.** — Arrangement of anti-friction rolling gear for 30-ton ironstone wagon; North Eastern Railway.

As is well known, the Westinghouse is the standard brake adopted on the North-Eastern Railway, but it was, on account of interchanging with other companies, considered desirable to fit these wagons with the Vacuum Brake Company's rapid-acting brake. Owing to the size of the bottom doors, it was impossible to arrange the brake and its gear below the underframe in the ordinary manner, and therefore the brake cylinder — 21 inches diameter — is slung as usual by trunnions from and between the stay plates above the underframe under one of the sloping ends of the body. The reservoir is further under the body. The brake shaft crosses the end of the wagon in front of the reservoir and is in two lengths. The piston rod is connected by links to a yoke, the ends of which are connected to the levers of the brake shaft so that the pull of the brake piston is equalised between the two pull rods which are connected to the short weigh shafts on either side of the wagon. The other parts of the rigging and the connection between the hand brake levers and the vacuum brake are of the usual kind and are clearly shown on the drawing. There are two brake blocks to each wheel. The train pipe for the reasons above given is brought round the outside of the side of the body. In the wagon shown in the figure 10, the hand brake levers are across the ends. This arrangement provides an "eitherside" brake at diagonal corners.

The most interesting feature about these wagons is the novel arrangement of the roller bearings, designed by the Anti-Friction Equipment (Railways) Company, Limited, and of this Mr. Worsdell has kindly supplied us with a detail drawing (figs. 11 and 12).

It will be seen that the weight is transmitted on to the bearing spring in the usual manner, but that the spring buckle sits on a cast steel yoke which is suspended by a pair of wrought-iron straps — 2 inches by  $\frac{3}{4}$  inch — from a brass-lined cast steel cap having a bearing on a gudgeon pin  $3\frac{1}{2}$  inches diameter by  $6\frac{3}{4}$  inches long, and which carries on its ends two cast steel rollers  $27\frac{1}{2}$  inches diameter by 2 inches long, and these rollers rest on the axle journals.

To the underside of the cast steel yoke carrying the spring is bolted the axle-box, which contains side brasses for communicating the motion of the wagon through the axle guards, which are double but of the ordinary pattern, in the usual manner.

The rollers make one revolution to five by the axle, and the gudgeon carrying them being only  $3\frac{1}{2}$  inches diameter, its surface speed of the frictional speed is little more than one-eighth that of the axle journal and the statical friction is reduced in a corresponding degree.

[ G36 .211.5 ]

#### 5. — Butterfly station platform canopies on the New York Central.

Figs. 13 and 14, p. 1484.

(*The Railway Gazette.*)

The accompanying drawings (figs. 13 and 14) show two designs of station platform canopies which will be used on all outlying stations in the New York Central electric zone. They are both of the inverted type, supported by a single row of posts down the center of the platform and drainage is towards a single gutter over the posts, the water being carried off through down spouts inside the posts. One design is for platforms flanked by tracks used exclusively for passenger trains. It extends out to within 4 feet of the center line of track and has an under clearance at eaves of 14 ft. 10 in. As will be seen from the outline of a standard passenger coach, the canopy affords almost complete protection when a train is standing at the station. In this design, the posts are made up of four light angles, latticed, and decreasing in size at the top. The ridge pole is a similar latticed box girder, the roof carlines are light plate girders and the purlins are I-beams, with channels at the eaves. This construction gives a graceful and pleasing appearance to the finished structure.

The other design shown is for station platforms flanked by tracks used for both freight and passenger traffic. The eaves are 6 feet from the center of the track, so as not to strike men riding on box cars. A somewhat simpler construction is used, two channels placed back to back, forming the posts and two Z-bars the ridge pole. No purlins are employed, the roof boards being nailed to nailing strips secured to the tops of the Z-bars and the channel eaves, which are riveted to the ends of the I-beam carlines. Both types of canopies will have composition roofing laid on the roof boards and deck lamps will be put in at frequent intervals under the ridge pole.

Regarding the name "butterfly canopy" which has been adopted by the railroad company an officer writes: "The term 'butterfly canopy' is expressive of the inverted type of umbrella sheds. In other words, the term 'umbrella sheds' applies to all classes of canopies supported by a single row of posts; and this class is in turn sub-divided into two types, one of ordinary 'A' construction and the other with an inverted covering which appears to be well named 'butterfly'."

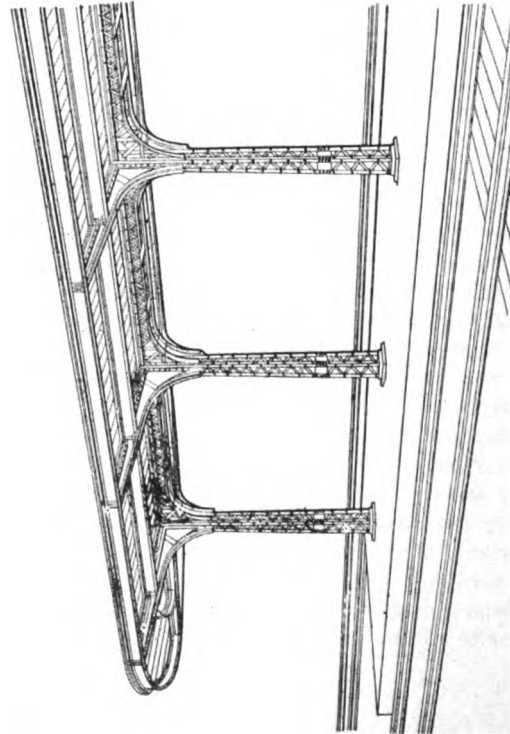
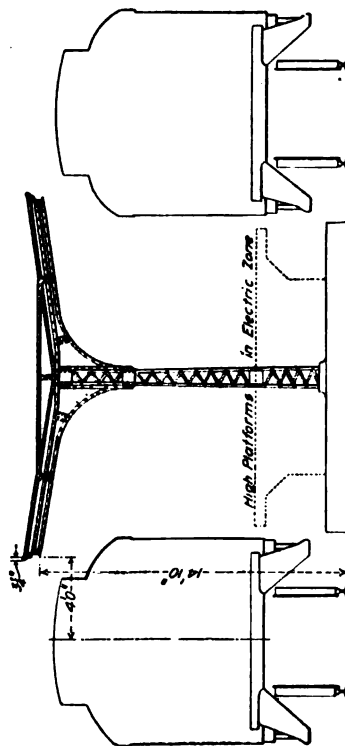


Fig. 13. — Butterfly canopy for platform with tracks for passenger traffic only.

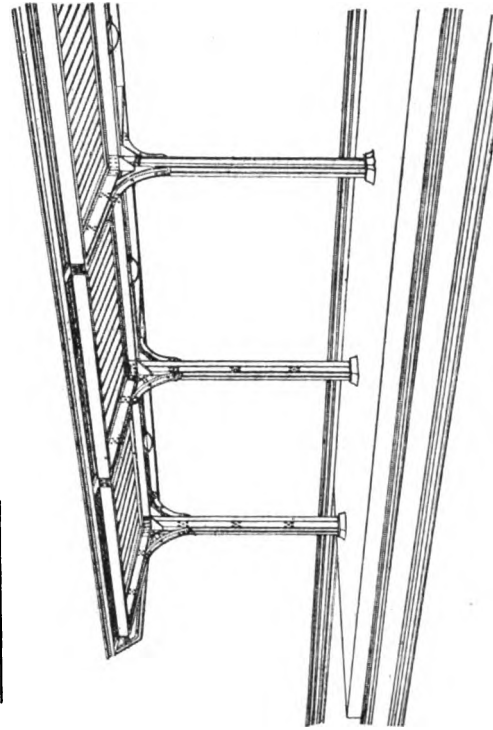
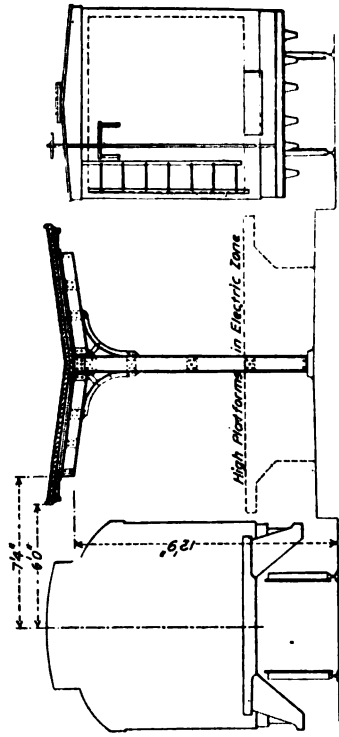


Fig. 14. — Butterfly canopy for platform with tracks for passenger and freight traffic.

The advantages claimed for the butterfly canopy are : 1° better opportunities for drainage and avoidance of drip from the eaves ; 2° better appearance ; 3° better protection for passengers, especially where tracks are operated exclusively with passenger equipment, for the reason that the outer edges of the canopies project over the car far enough to shield the platforms from storms.

[ 656 .28 (01 ) ]

**6. — Colonel H. A. Yorke's report on the accident of January 2, 1906.  
between Strathaven and Stonehouse on the Caledonian Railway.**

Fig. 15, p. 1487.

(*The Railway Engineer.*)

The 6.50 p. m. passenger train (4-coupled tank engine running bunker first and five 8-wheeled carriages) *ex* Strathaven was derailed about 1  $\frac{1}{2}$  miles from Strathaven. The engine and one coach were overturned. The driver, the fireman (right arm torn off), and 7 passengers were injured.

The railway between Strathaven and Stonehouse was opened for passenger traffic in June, 1905. The line is single, and is laid with steel rails weighing 80 lb. per yard, and 32 feet in length ; chairs weighing 46 lb., each with a base having a bearing area on the sleepers of 105 square inches. There are four spike holes in the base of each chair, but the custom on the Caledonian Railway is to use, in the first instance, only two spikes (one outside and one inside), the spikes being  $\frac{7}{8}$  inch diameter and 5  $\frac{3}{4}$  inches long. When the spikes first inserted begin to work loose and to become deficient in holding power, they are reinforced by the insertion of the two additional spikes.

The derailment occurred on a gradient of 1 in 65·95, falling from Strathaven to the viaduct over the Avon Water, about  $\frac{1}{4}$  mile beyond the site of the accident. There are numerous curves on the line, and the derailment took place at the commencement of a right-handed (travelling towards Stonehouse) curve of 20 chains radius. This curve is situated in a cutting, and the railway is crossed near the commencement of the curve by an overbridge leading to Whinknowe Farm. The outer rail of the curve has a superelevation of 4 inches.

After the accident, the first rail length from the Whinknowe bridge was in place and undamaged ; the second rail length had been thrown out of alignment between the joints towards the outside of the curve to the extent of 2 or 3 inches. Both rails had moved together, so that, though out of alignment, the line was not out of gauge. The third rail length had moved in a similar manner between the joints, but to a less extent. From the commencement of the fourth rail on the high side of the curve, two chairs remained undamaged ; the third and fourth chairs had wheel marks on their bases on the inside of the rail, and from that point onwards to the place where the engine stopped all the chairs of this rail were broken and the sleepers cut in half. On the inner rail, the chair next but one to the third rail joint on the Strathaven side was partly tilted up ; the next chair, namely, that adjacent to the joint, was broken ; the first four chairs of the fourth rail were broken, and from that point the chairs of the inside rail were torn off from the sleepers, the inner rail being pushed out of place as far as the spot where the engine came to rest.

The engine was a tank engine of the 0-4-4 type. The wheelbase of the bogie 6 feet and of

the coupled wheels 9 feet, the distance from the bogie pin to the nearest driving axle being 9 ft. 10 in. The bogie wheels were 3 ft. 2 in. diameter, and the driving wheels 5 feet. The weight of the engine was 50 tons 6  $\frac{3}{4}$  cwt., distributed as follows : On the bogie, 15 tons 9 cwt.; on the middle wheels, 18 tons 7  $\frac{1}{2}$  cwt.; on the trailing wheels, 16 tons 10  $\frac{1}{4}$  cwt.

The Caledonian Railway practice as to spiking chairs does not seem good, because the first two spikes, having lost their holding power, do not afford any support to the second lot of spikes, and these, therefore, are exposed to the same forces as the first lot of spikes, and work loose in the same manner, whereas if all four spikes were used from the first, they would afford each other mutual support, and a more durable fastening would be obtained. This practice has recently been abandoned by the Co. on their main line, but it was adopted on the Strathaven branch.

A superelevation of 4 inches is suitable for a speed of about 38 miles an hour. The line was opened for passenger traffic in June, 1905, and about six months later, it was found that the spikes of the chairs on the outside of the curve where the accident happened, and of another adjacent curve, had worked loose, and that the high rail was being pushed out of place. It was, therefore, decided to add two additional spikes to each of the chairs on the outside of these two curves, the chairs of the inner rail being left with two spikes.

On the 2<sup>nd</sup> January, driver Matthew Stewart, while taking the 4.7 p. m. train from Glasgow to Strathaven, noticed a lurch of unusual severity when he was passing round the curve at about 25 miles an hour. On the return journey he again felt the lurch, although he had taken the precaution to reduce the speed to 10 or 12 miles an hour. On arriving at Larkhall Central Station, he told the signalman to warn drivers of the bad bit of road between Cotcastle and Strathaven.

The next train was the 5.14 from Glasgow to Strathaven. On the arrival of this train at Larkhall Central, the signalman warned the driver (John Major) that there was a bad bit of road near the overbridge between Stonehouse and Strathaven. Major thought the warning had reference to the portion of line between Larkhall and Stonehouse. The train reached Strathaven, however, without any mishap, and Major says that he felt nothing unusual at any place. Major started back from Strathaven at 7.11 p. m., being twenty-one minutes late, his engine then having its bunker in front. There is a gradient of 1 in 66, falling from Strathaven to the curve, a distance of about 1  $\frac{1}{2}$  miles. After passing the overbridge Major felt his engine give a lurch, first to the low side of the curve, and then to the high side, after which he found it was off the road. Almost immediately afterwards it turned over on its side, and after sliding some distance came to rest about a train's length from where it first left the rails. The position of the train was then as follows : The whole train was off the road on the left or high side of the curve; the engine and the carriage next to it were overturned on their left sides; the second carriage was leaning over towards the left at an angle of about 45°; while the third, fourth and fifth carriages were standing upright on the ballast. All the wheels of the train were off the rails except the two right-hand wheels of the rear bogie of the rear carriage.

The plan (fig. 15) shows that the road had been more or less out of alignment. Major's engine, which was running bunker first, on reaching the curve probably forced the high rail out of place sufficiently to allow its inner wheels to drop off the rail of the curve on to the ballast. As soon as this occurred, the inner rail was also forced outwards, and the left-hand wheels of the engine dropped off the high rail on to the ballast, thus "bursting the road" and forcing both rails still more out of their positions, and cutting the sleepers in half. The seventh joint of the high rail was then broken and the rail torn out of its chairs, the engine and front coach getting outside it.

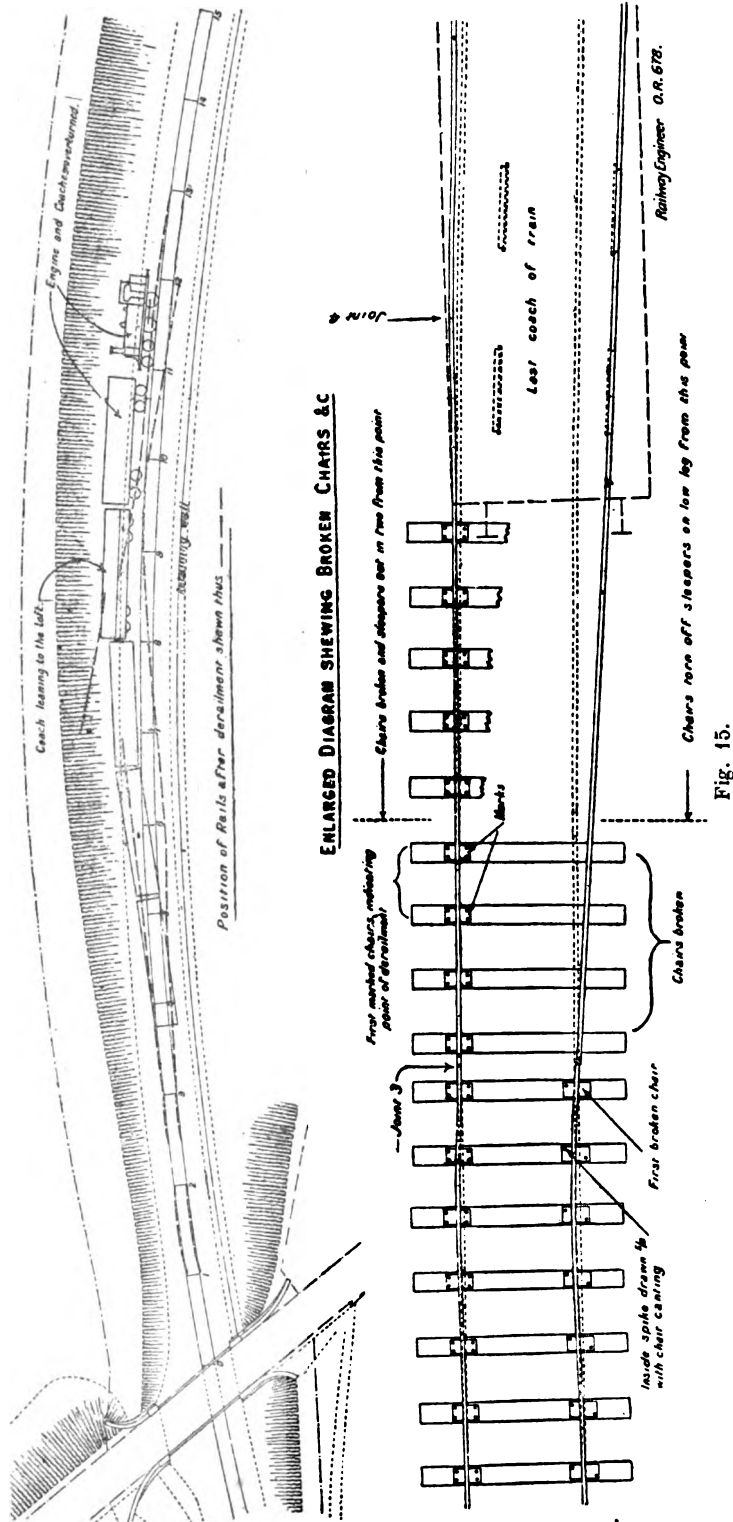


Fig. 15.

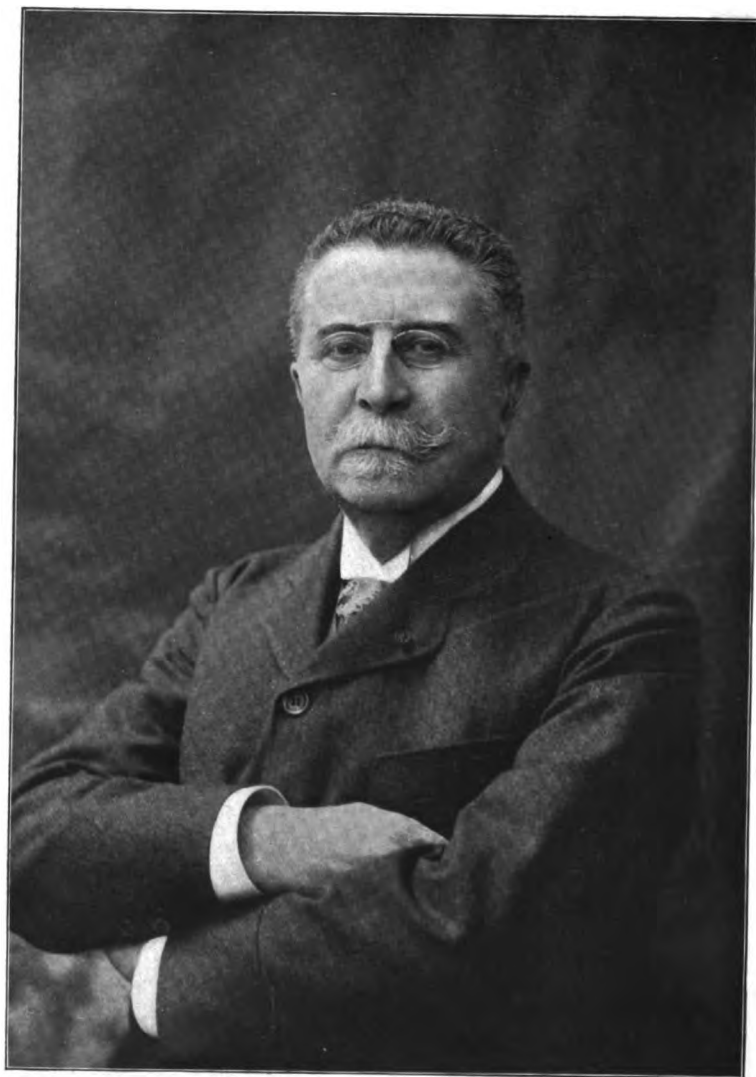
The left hand wheels of the engine either sank deep into the ballast or got into the ditch alongside the road bed, and in this way caused the engine and coach to be overturned; and it was probably due to the overturning of these vehicles that the train stopped in so short a distance, *viz.*, about 95 yards.

The accident was due to the condition of the permanent way, which in turn was caused, according to the evidence of the permanent way inspector Muir, by the speed at which trains have been allowed to run down the incline. The road is a new one and not thoroughly consolidated, and the curve in question, having a superelevation of only 4 inches, was unsuitable for a speed of 50 miles an hour, which is the speed Muir says trains frequently attain at that place. Although there is a restriction of speed to 10 miles an hour over the Avon viaduct, which is situated about  $\frac{1}{4}$  mile on the east side of the scene of the accident, there is no restriction laid down for the place where the accident occurred, and therefore no blame would belong to driver Major, but for the fact that he had been warned that there was a dangerous place somewhere between Larkhall and Strathaven. After receiving that warning, and especially as he did not clearly know exactly where this place was situated, it was his duty to have run at a moderate speed and with reasonable care.

Both permanent way inspector Muir and foreman platelayer Campbell say that they have seen trains running round the curve where the accident happened at a speed for which it was not suitable, and yet they made no report of the matter to any of their superior officers. The fact that the road required double spiking so soon after opening, should have been in itself sufficient proof that it was being subjected to too great a strain. Although these men knew that danger was being daily incurred, they took no steps to avert it, and by their silence incurred a grave responsibility. Rule 6 in the General Rule Book says that "The safety of the public must under all circumstances be the chief care of the servants of the Company", and it is clearly the duty of every servant to report to his superior officer anything that he knows is wrong.

The Company should settle, on the advice of the engineer, what the speed of trains should be, and impress upon all servants the necessity for immediately reporting any breach of the instructions. Both rails should invariably be double spiked and curves situated at the foot of a long incline should be provided with check rails.





**Ernest Blagé.**

# OBITUARY

---

Ernest BLAGÉ,

Engineer in chief of bridges and roads,

Honorary general manager, consulting officer to the French Midi Railway,

Member of the Permanent Commission of the International Railway Congress Association,

Delegate to the sessions of Milan (1887), Paris (1889 and 1900), St. Petersburg (1892) and London (1895).

The Permanent Commission of our Association has recently been deprived by death of one of our oldest colleagues, Mr. Blagé, who had gained amongst us and the members attending our sessions, the warmest affection and the highest esteem. The ex-general manager of the Midi Railway, possessed great ability and unerring judgment, and at the same time an unalterable decision in conjunction with immutable suavity and kindness of heart. Perhaps he had only one fault, namely that he took too deeply to heart the worries, disappointments and disillusiones that are inseparable from the management of a great railway, so, much so that his health broke down prematurely, and he had to give up his duties as general manager of the Midi Company at the age of 58.

On the 18<sup>th</sup> of May last, his many friends and his family had to deplore his loss through a long and painful disease which he bore with the greatest fortitude. We trust that his devoted wife and children will accept our sincerest condolences on their loss.

Those who have attended our meetings will, we believe, be glad if we briefly sketch the main features of our late colleague's brilliant career.

Born at Toulouse on March 11, 1845, he was one of the most successful candidates for admission to the Polytechnic School in 1865. When he left the School of bridges and roads in 1870, he was appointed engineer at Mont-de-Marsan in June, 1870, at the time when war was declared between France and Germany. Refusing the exemption from military service to which he was entitled, he was appointed chief of a squadron of artillery mobilised in the Landes department, and through to his brilliant conduct, he gained many most devoted and close friends. When the war was over, he took up ordinary engineering duties at Albi and in this position he was occupied in railway surveying. In 1877, he entered the service of the Midi Railway and was attached to the traffic department at Bordeaux. He at once brought himself to the notice of the general manager of the company, Mr. Huyot, owing to his aptitude for general matters, and in April 1878 he was attached to the Paris head office.

Mr. Lancelin, when he succeeded Mr. Huyot, took him as his assistant in July 1883 and appointed him specially to investigate the laborious subject of the conventions of 1883 with the French Government regarding the concession of additional lines.

When Mr. Lancelin died prematurely owing to the devotion he showed during the epidemic of cholera in 1884, Mr. Blagé was appointed general manager of the Midi at the age of thirty nine. He began his duties during a serious industrial and commercial crisis which brought down heavily the earnings of the railways in the Midi districts, injured mainly by the ravages of the phylloxera in one of the essential factors of its prosperity, the production of wine. The earnings of the company fell suddenly from 100 to 83 millions (£4 millions to £3,320,000). Mr. Blagé was in his element during these trying circumstances. By his steadfast will, eminent judgment and unceasing application, he was able to effect the necessary economies without bringing suffering upon the staff. With this end in view, he simplified and improved the methods of working and did away with useless machinery; he reduced the cost of the head-quarters' management; in a word, he substituted a truly commercial management for an administrative organisation that had too much resembled that of one of the State departments.

In 1898, he was just about to profit by his exertions and see the company return to its former prosperous condition, when he was forced to agree to the State purchase of the Garonne lateral canal and the Midi canal, till then worked by the Midi. The object of this purchase was to abolish the tolls upon these canals, which henceforth were to compete disastrously with the parallel railways.

Thanks to the application of lower rates on the line between Bordeaux and Cette and other sources of economy, Mr. Blagé succeeded in getting the traffic to resume its upward tendency after a comparatively short period of depression. But the tremendous exertions he had to make to attain this result, entirely exhausted his strength and he was obliged to resign the active management of the Midi system in 1902. He still, however, had the satisfaction of seeing his work completed in the able hands of his successor, Mr. Glasser, and the position of his company thoroughly reestablished in 1904, when it ceased to make a call upon the State guarantee.

We may add that Mr. Blagé always followed with the keenest interest the labours of our Association; he often took an active share in our debates, and at times, he was inspired by information derived from abroad through us to institute interesting reforms on the Midi Railway. As an example, we may more especially mention the introduction of the automatic block-system.

*The Committee of Management.*

---

# List of the papers published for the Fifth Session.

ENGLISH EDITIONS (IN RED COVERS).

NUMBER of the pamphlet.	NUMBER of the Question.	TITLE OF THE QUESTION.	CONTENTS.	PRICE.	
				Excluding postage.	Including postage.
4	XX	Brakes for light railways . . . . .	Report, by Mr. Ploeg . . . . .	FR. C. 1 50	FR. C. 1 60
2	V	Boilers, fire-boxes and tubes . . . . .	Addenda, by the same. . . . .		
3	XVI	Decimal system. . . . .	Report, by Mr. Ed. Sauvage . . . . .	3 "	3 15
4	XIX	Light railway shops . . . . .	— by Mr. J.-L. Wilkinson . . . . .	1 50	1 60
5	XV	The twenty-four hours day. . . . .	— by Mr. Terzi . . . . .	1 50	1 60
6	XIII	Organisation. . . . .	— by Messrs. Scolari and Rocca. . . . .	1 50	1 60
7	X	Station working . . . . .	2 <sup>nd</sup> report (for English speaking countries), by Mr. Harrison. . . . .	1 50	1 60
8	XI	Signals . . . . .	2 <sup>nd</sup> report on parts A and B (for English speak- ing countries), by Mr. Turner . . . . .	2 25	2 40
9	I	Strengthening of permanent way in view of increased speed of trains. . . . .	2 <sup>nd</sup> report (for English speaking countries), by Mr. Thompson . . . . .	2 25	2 40
10	VI	Express locomotives . . . . .	1 <sup>st</sup> note, by Mr. Raynar Wilson. . . . .		
11	II	Places in permanent way requiring special atten- tion. . . . .	2 <sup>nd</sup> report (for English speaking countries), by Mr. William Hunt . . . . .	3 "	3 20
12	XIII	Organisation. . . . .	Addenda by the same. . . . .	7 50	7 90
13	VII	Rolling stock for express trains . . . . .	Report, by Mr. Aspinall. . . . .	1 50	1 60
14	III	Junctions. . . . .	— by Mr. Sabouret . . . . .		
15	...	The history, organisation and results of the Inter- national Railway Congress. . . . .	1 <sup>st</sup> report (for non-English speaking countries), by Mr. Duca . . . . .	9 "	9 40
16	IX	Acceleration of transport of merchandis . . . . .	Report, by Mr. C.-A. Park. . . . .	2 "	2 10
17	XII	Cartage and delivery. . . . .	— by Mr. Zanotta . . . . .	3 "	3 15
18	XI (See also N° 8)	Signals . . . . .	Note, by Mr. A. Dubois . . . . .	2 50	2 65
19	XVII-A	Light feeder lines (contributive traffic). . . . .	Report, by Mr. H. Lambert . . . . .	1 50	1 60
20	XIV	Settlement of disputes . . . . .	Report, by Mr. H. Twelvetees . . . . .	1 50	1 60
21	XVIII	The working of light railways by leasing com- panies. . . . .	1 <sup>st</sup> note, by the Belgian State Railways Ad- ministration. . . . .		
22	IV	Construction and tests of metallic bridges . . . . .	2 <sup>nd</sup> note, by the Western Railway of France Administration. . . . .		
23	X	Station working. (Methods of accelerating the shunting of trucks.) . . . . .	1 <sup>st</sup> Report (for non-English speaking countries), by Mr. Motte. . . . .	3 75	3 95
24	...	Railway progress in the Dominion of Canada . . . . .	2 <sup>nd</sup> note, by the Mediterranean Railway Company (Italy). . . . .		
25	I (See also N° 9)	Strengthening of permanent way in view of increased speed of trains. . . . .	3 <sup>rd</sup> note, by Mr. Theo.-N. Ely. . . . .		
26	XVII-B	Relaxation of normal requirements for light rail ways. . . . .	4 <sup>th</sup> — by the American Railway Association (Messrs. A.-W. Sullivan and F.-A. Delano). . . . .	1 50	1 60
27	VIII	Electric traction . . . . .	5 <sup>th</sup> note, by Mr. Robert Pitcairn. . . . .	1 50	1 60
28	XIV (See also N° 20)	Settlement of disputes . . . . .	6 <sup>th</sup> — by Mr. A.-T. Dicoe. . . . .	1 50	1 60
29	I (See also N° 9 and 25)	Strengthening of permanent way in view of increased speed of trains. . . . .	Report, by Mr. De Backer. . . . .	1 50	1 60
30	A	Technical information on the breaking of steel rails. — on the current cost of metal- lic compared with wooden sleepers. . . . .	— by Mr. De Peri. . . . .	3 75	3 95
31	B	Technical information on the life of wooden sleepers of different kinds, not pickled or pickled according to various processes. . . . .	Note, by Mr. W.-M. Acworth. . . . .	4 50	4 75
32	C	Technical information on locomotive crank axles. . . . .	Report, by Mr. Max Edler von Leber. . . . .		
33	D	— on locomotive fire-boxes . . . . .	1 <sup>st</sup> report on Part A (for non-English speaking countries), by Mr. J. de Richter . . . . .	6 "	6 30
34	E	— on locomotive boilers . . . . .	1 <sup>st</sup> report on Part B (for non-English speaking countries), by Messrs. Eug. Sartiaux and A. von Boschan. . . . .		
35	F	— on the lubrication of rolling stock. . . . .	1 <sup>st</sup> note, on Part B, by Mr. Ast 2 <sup>nd</sup> — by the Administration of the "Kaiser Ferdinand Nordbahn". . . . .	1 50	1 55
36	G	Technical information on shunting engines and on the movement of the staff in different coun- tries. . . . .	Memorandum, by the Hon. Sir Charles Tupper. Report, by Mr. Ast (first part) . . . . .	2 25	2 40
37	H and I	Technical information on shunting engines and on the movement of the staff in different coun- tries. . . . .	Report, by Messrs. Humphreys-Owen and P.-W. Meik. . . . .	3 "	3 15
38	H and I	Technical information on shunting engines and on the movement of the staff in different coun- tries. . . . .	1 <sup>st</sup> note, by Mr. E.-A. Ziffer. . . . .		
39	H and I	Technical information on shunting engines and on the movement of the staff in different coun- tries. . . . .	3 <sup>rd</sup> — by the Hon. Thomas C. Farrer. . . . .	6 50	6 80
40	H and I	Technical information on shunting engines and on the movement of the staff in different coun- tries. . . . .	Report, by Mr. Auvert. . . . .		
41	H and I	Technical information on shunting engines and on the movement of the staff in different coun- tries. . . . .	1 <sup>st</sup> note, by the Western of France Railway. . . . .		
42	H and I	Technical information on shunting engines and on the movement of the staff in different coun- tries. . . . .	2 <sup>nd</sup> — by the Northern of France Railway. . . . .		
43	H and I	Technical information on shunting engines and on the movement of the staff in different coun- tries. . . . .	3 <sup>rd</sup> — by Mr. Ernest Gerard . . . . .		
44	H and I	Technical information on shunting engines and on the movement of the staff in different coun- tries. . . . .	Note, by Mr. Chas. J. Owens. . . . .	1 50	1 55
45	H and I	Technical information on shunting engines and on the movement of the staff in different coun- tries. . . . .	Report, by Mr. Ast (second part). . . . .	3 50	3 70
46	H and I	Technical information on shunting engines and on the movement of the staff in different coun- tries. . . . .	Report, by Mr. Bricka . . . . .	1 50	60
47	H and I	Technical information on shunting engines and on the movement of the staff in different coun- tries. . . . .	— by Mr. Kowalski . . . . .	3 "	
48	H and I	Technical information on shunting engines and on the movement of the staff in different coun- tries. . . . .	— by Mr. V. Herzenstein . . . . .	7 "	
49	H and I	Technical information on shunting engines and on the movement of the staff in different coun- tries. . . . .	As the information collected on this question was very incomplete, it was not dealt with. . . . .		
50	H and I	Technical information on shunting engines and on the movement of the staff in different coun- tries. . . . .	Report, by Mr. Hodeige. . . . .	6 "	6 30
51	H and I	Technical information on shunting engines and on the movement of the staff in different coun- tries. . . . .	— by Mr. Belleruche . . . . .	3 50	3 70
52	H and I	Technical information on shunting engines and on the movement of the staff in different coun- tries. . . . .	— by Mr. Hubert . . . . .	3 50	3 70
53	H and I	Technical information on shunting engines and on the movement of the staff in different coun- tries. . . . .	As the information collected on these questions was very incomplete, it was not dealt with. . . . .		

N. B. — The numbering of the pamphlets (see first col.) issued in French and English is not the same. The English editions are in red covers and the French editions in brown covers.

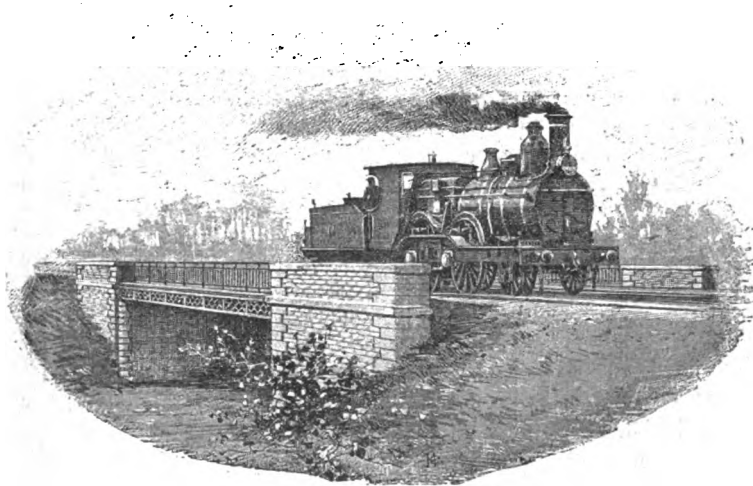
CONTENTS.	PAGES.	NUMBERS OF PLATES AND FIGURES.	NUMBERS of the DECIMAL CLASSIFICATION.
I. — NOTE on the tightness of foundation rings, by O. BUSSE . . .	1345	...	621 .133.2
II. — Wheel carrying rail joints and tie preservation, by Max BARSCHALL . . . . .	1348	Figs. 1 to 8, pp. 1350 to 1353.	625 .143.4 & 625 .142.2
III. — NOTE on determining the power of locomotives by means of the speed curves, by Dr. Karl SCHLOSS . . . . .	1355	Figs. 1 to 6, pp. 1357 to 1364.	621 .131.1
IV. — Superheated steam on the Canadian Pacific Railway . . . .	1365	...	621 .134.3
V. — PROCEEDINGS OF THE SEVENTH SESSION (2 <sup>nd</sup> section, locomotives and rolling stock):			
Question VIII : Electric traction. Sectional discussion. Report of the 2 <sup>nd</sup> and 5 <sup>th</sup> sections meeting jointly. Discussion at the general meeting. Conclusions . . . . .	1373	Fig. 1, p. 1388.	621 .33
Appendix I : Corrigenda to the report No. 2, by Ernest GERARD . . . . .	1420	..	...
— II : Letter from C. Rota and E. Grismayer on Mr. Victor Tremontani's report No. 4. . . . .	1421	...	621 .33
— III : Remarks on Mr. Victor Tremontani's report No. 4, by Coloman de GÜLÁCSY . . . . .	1422	...	621 .33
VI. — PROCEEDINGS OF THE SEVENTH SESSION (3 <sup>rd</sup> section, working):			
Question IX : Lighting, heating and ventilation of trains. Sectional discussion. Report of the 2 <sup>nd</sup> and 3 <sup>rd</sup> sections meeting jointly. Discussion at the general meeting. Conclusions . . . . .	1429	...	625 .233 & 625 .234
VII. — MISCELLANEOUS INFORMATION :			
1. The world's railways . . . . .	1468	...	313 .365 (.3)
2. Union Pacific motor car No. 7. . . . .	1473	Fig. 1, p. 1473.	621 .132.8
3. 200,000 lb. capacity flat car. . . . .	1474	Figs. 2 to 6, pp. 1477 and 1478.	625 .241
4. 30-ton ironstone wagon; North-Eastern Railway . . . . .	1476	Figs. 7 to 12, pp. 1479 to 1482.	625 .242
5. Butterfly station platform canopies on the New York Central. . . . .	1483	Figs. 13 and 14, p. 1484.	656 .211.5
6. Colonel H. A. Yorke's report on the accident of January 2, 1906, between Strathaven and Stonehouse on the Caledonian Railway . . . . .	1485	Fig. 1, p. 1487.	656 .28 (01
VIII. — OBITUARY : Ernest Blagó . . . . .	1491	One portrait.	385. (09.2
IX. — MONTHLY BIBLIOGRAPHY OF RAILWAYS :			
I. Bibliography of books . . . . .	85	...	016 .385. (02
II. — of periodicals . . . . .	87	...	016 .385. (05

YEARLY SUBSCRIPTION (Jan. to Dec. *only*) PAYABLE IN ADVANCE, £1.4s. = \$6.

Vol. XX. — No. 10. — October, 1906. 11<sup>th</sup> Year of the English Edition.

---

**BULLETIN**  
OF THE  
**INTERNATIONAL RAILWAY CONGRESS**  
ASSOCIATION  
(ENGLISH EDITION)  
[ 385. (05) ]



Editorial communications should be addressed  
to the Permanent Commission (Executive Committee) of the International Railway Congress Association  
rue de Louvain, 11, Brussels.

**BRUSSELS**  
PUBLISHED BY P. WEISSENBRUCH, PRINTER TO THE KING  
49, rue du Poinçon.

**LONDON**  
P. S. KING AND SON, PARLIAMENTARY AND GENERAL BOOKSELLERS  
2 and 4, Great Smith Street, Westminster, S. W.

The Permanent Commission of the Association is not responsible for the opinions expressed  
in the articles published in the BULLETIN.

# NOTICE

---

All editorial communications intended for the *Bulletin* should be addressed to Mr. Louis Weissenbruch, General Secretary of the Permanent Committee, International Railway Congress Association, 11, rue de Louvain, Brussels. The *Bulletin*, which is published in monthly numbers forming an annual volume of more than 800 pages, contains the whole of the proceedings and publications of the Congress of every kind. Copies are sent gratuitously to all the Companies, members of the Congress, at the rate of one copy for each delegate which the Company is entitled to send to a Congress meeting with one extra copy for the Company's own library.

The *Bulletin* can be supplied at the rate of 25 francs = £1 = \$5 per annum, not including postage; or 30 francs = £1.4s. = \$6 including postage to subscribers who send their subscriptions in advance by cheque or postal order direct to the publisher, Paul Weissenbruch, 49, rue du Poinçon, Brussels.

---

*N. B.* — The annual subscription, which must be paid in advance and dates from the January of the year for which the subscription is sent, does not vary even when the number of pages in the year's issue greatly exceeds 800 pages (the 1900 volume of the English edition consisted of 3988 pages). But the price of each monthly number, if bought separately, is fixed according to the number of pages it contains as follows:

2s. (50 cents) per 72 pages not including postage.

It is therefore evident that there is a great gain in subscribing for the whole year.

---

The whole years 1896, 1897, 1898, 1899, 1900, 1901, 1902, 1903, 1904 and 1905 of the English edition of the *Bulletin* containing 1,370, 1,824, 1,634, 1,695, 3,988, 2,734, 1,129, 1,353, 2,066 and 2,626 pages, may be obtained each at 35 francs = £1.8s. = \$7, including postage.

---

Previous volumes of the *Bulletin*, published in French only, contained 1,574, 1,196, 2,194, 1,576, 749, 4,114, 1,124, 1,118, 3,812 and 1,632 pages, illustrated with numerous plates and diagrams, for the years 1887 to 1896 respectively may be obtained at the same price.

---

PAPERS PUBLISHED FOR THE FIFTH SESSION : A detailed list of the papers, notes, and technical information, prepared for the London meeting, is given on the third page of the cover.

Copies may be had on application to the publisher, 49, rue du Poinçon, enclosing remittance of the price as given in the list opposite each paper on the third page of the cover. (*N. B.* 1 franc = 10d. = 20 cents.)

**BULLETIN**  
OF THE  
**INTERNATIONAL RAILWAY CONGRESS**  
**ASSOCIATION**  
(ENGLISH EDITION)

---

[ 628 .61 (.42) ]

**BURTON AND ASHBY LIGHT RAILWAY,**

By SEYMOUR GLENDENNING.

Figs. 1 to 7, pp. 1495 and 1496.

(*The Railway Magazine.*)

An English railway laid on the public highway — thus a prominent weekly contemporary briefly, but aptly, describes the Midland Railway's new light railway from Burton to Ashby. For many years there has been in use between the two points named a heavy steam railway, which forms a section of the Midland Railway Company's line from Burton to Leicester, but, owing to the formation of the country, it takes a somewhat circuitous route. In fact, this iron road forms part of a girdle of rails round south Derbyshire — a rough circle, in which the chief points of the compass are represented by Stenson in the north, Ashby in the south, Tonge in the east, and Burton in the west; while the centre of this somewhat flattened ring of rails may be placed near The Scaddows, about midway between Ticknall and Hartshorn. The railway from Derby to Burton is fairly straight, because it crosses the outskirts of Sinfin Moor, and then follows the valley of the Trent; but the lines from Derby to Ashby both go round about to avoid the hilly country of South Derbyshire, where, in consequence, the old-fashioned carrier's cart still reigns supreme. In the south-western quarter of the circle, there is a branch from the Burton and Ashby Railway, in the form of an elongated horseshoe loop, which is a single line of rails to serve Swadlincote and Woodville — laid along a lateral valley, and then doubling back through a tunnel and down another valley to rejoin the main line near Gresley. It thus happens that, although the bustling and thriving townships of Swadlincote and Woodville have railway communication to Ashby and Burton, it is decidedly indirect, while the very populous mining village of Newhall, with something like eight thousand or nine thousand inhabitants, has no station at all, and it was mainly due to this lack that a demand arose for a light railway to mount the hills and

follow the direct route along the ridges, instead of keeping to the valleys, where there are but few industrial concerns, and only a very small population.

A Bill was brought before Parliament, but eventually withdrawn, owing to the opposition of the Midland Railway, which, however, agreed to carry out the project itself. That was two years ago, and the new light railway, ten miles long, has now been completed.

Of course, steam power plays no part in it, electricity being considered superior in a railway of this description, where numerous very steep gradients have to be climbed.

In fact, to all intents and purposes, it is an electric railway, laid upon the public highway, with stopping places at all penny stages and intermediate points, while the various villages and towns through which it passes will practically serve as stations. As will be seen from the illustrations of Bretby and Newhall, figures 3 and 4, a good length of the line at these places resembles that of a branch railway, fenced or hedged in on either side, this being necessary in consequence of short cuts across fields or garden plots.

The electric current is taken from an overhead cable, suspended from steel poles or standards, placed at frequent intervals along the line of route.

As a rule, railway companies purchase land on which to construct their permanent way, but, in the present case, the greater part of the track is laid singly and on one side of the public highway, a double road being laid at frequent intervals to serve as crossing places. An enormous expense, however, has been incurred in widenings and clearance. For nearly half-a-mile in Newhall, the street has had to be widened, involving the demolition of a number of houses and the clearing away of numerous front gardens. In Ashby itself, also, where the tram has to take some very abrupt curves on its tortuous way to the station, valuable property has been cleared away in Bath Street and Market Street, in order to afford a safe route for the cars.

It is interesting to note that the new line touches no less than three counties, for it begins in Staffordshire, stretches across South Derbyshire, and ends in Leicestershire. The country through which it passes is very diverse in character, and the interests that it serves are no less so. At the western extremity is Burton, with its huge breweries, which supply a great part of the world's beer. It was intended at first that, after crossing the Trent Bridge, the railway should leave Burton up a steep slope between the Winshill and Stappenhill roads, but eventually it was mutually agreed between the town and the railway that the Corporation track should be used as far as Winshill. The new line, therefore, begins at High Bank Road, with a very deep curved gradient up to Moat Bank, where a height of 250 feet above Burton is reached. A fine stretch of hilly country then opens to view, with Brizlincote Hall on the right; next the line dips 60 feet to cross a lateral valley. Then it rises again, and follows a number of switchback undulations until it enters Newhall, which is 400 feet above ordnance survey datum line. Newhall furnishes a strong contrast to the fair country west of it. Collieries, brick yards, and pipe works abound. Newhall displays the characteristics of mining villages, *i. e.*, it is dingy, squalid, and untidy. However, its teeming population will doubtless find the new line a very great convenience, both for business and pleasure purposes, and there seems little doubt but what the Midland Railway Company will reap a continued harvest of fares from the thousands of miners and their families. From Newhall, the level of the track gradually descends until it is below 200 feet, and then leaves the Ashby main road to take a right-angled turn into Swadlincote. Here the line, after going due south for a time, is carried over the old railway — the single loop to Swadlincote and Woodville before mentioned — on a long bridge of steel girders, resting on blue brick piers. The bridge, as will be seen from the figure 2, has a switchback appearance, while the figure 7, taken from Swadlincote goods yard, shows a Midland Railway train passing under it.

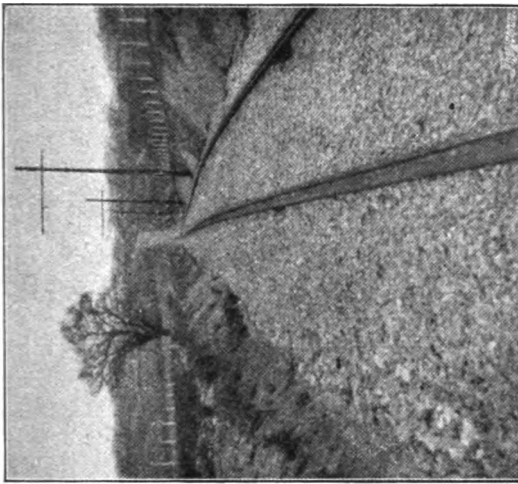


Fig. 3. — Some severe gradients near Brethly.

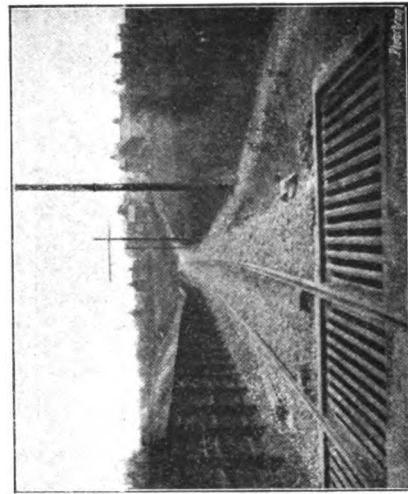


Fig. 4. — Cattle fence at Newhall.

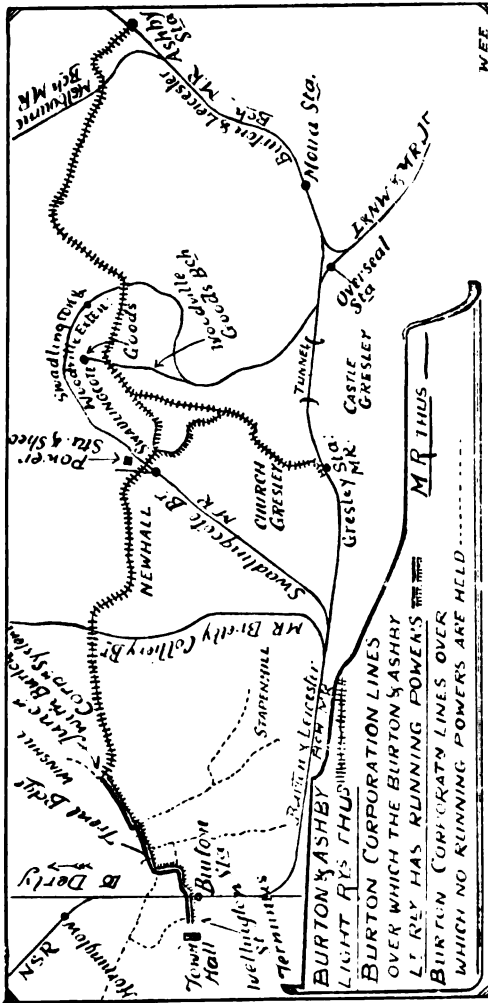


Fig. 1. — Map of the Burton and Ashby Light Railway and surrounding lines.

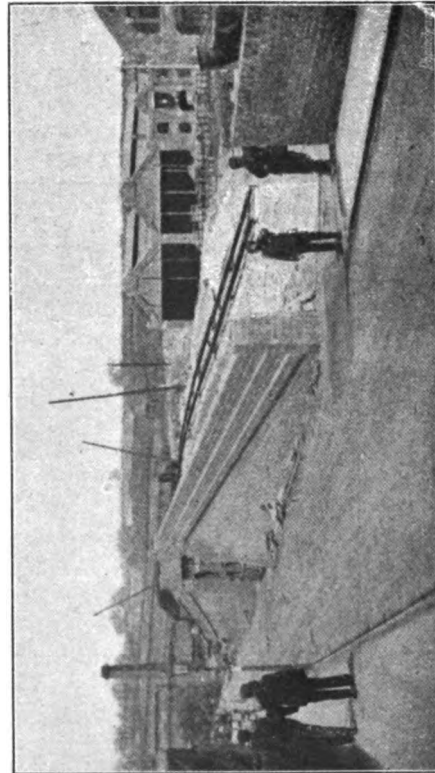


Fig. 2. — Switch-back bridge at Swadlincote carrying the Light Railway over the Midland Railway.

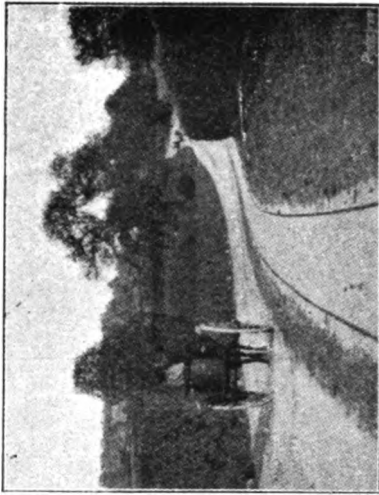


Fig. 6. — The railway alongside the road, near Burton.  
569 feet above sea level.



Fig. 7. — The Midland Railway at Swadlincoke.  
The Light Railway is carried across the standard railway by means of the bridge seen in the picture.

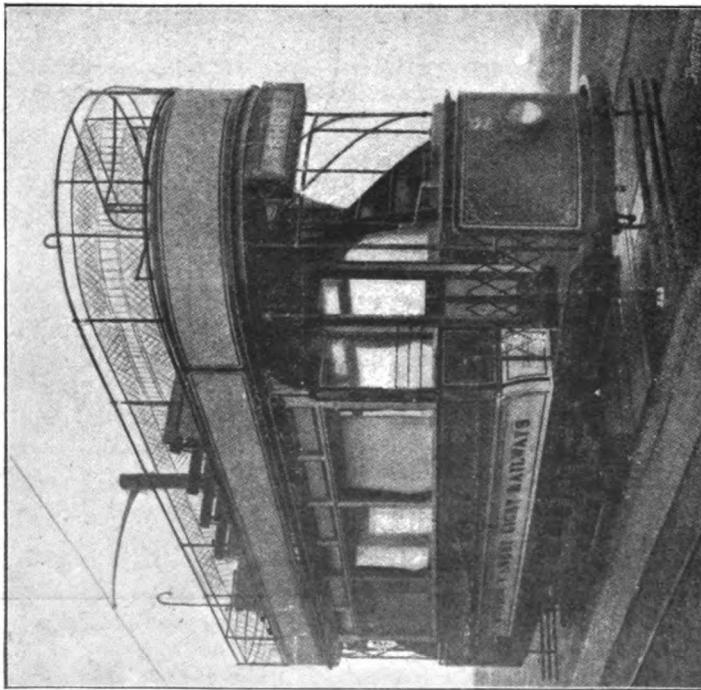


Fig. 5. — Electric car, Burton & Ashby Light Railway.

Shortly after crossing the bridge the track takes an abrupt turn to the left, in order to resume its eastward direction. At the same place, there is a branch about two miles long, going first south and then southwest to Gresley. The road towards Ashby rises continuously until it reaches a height of 569 feet above sea level. It passes through the heart of the Derbyshire Potteries, where a great industry is carried on in the manufacture of furnace bricks, sanitary pipes, and common earthenware. Furnaces and kilns abound in Swadlincote, and the subsidiary industry of crate making is also much in evidence.

There are numerous stacks arranged in the form of a lofty cone, of the long tapering branches of timber with untrimmed bark, which are used for making the big rectangular crates for the conveyance of heavy earthenware.

The clay for the pipes and pots is obtained on the surface, but the fire clay for furnace bricks has to be reached from a depth, by sinking shafts equipped with hoisting machinery. Imperceptibly, Swadlincote grows into Woodville, where the large pipe works are situated, with their groups of ever-smoking furnaces and yards, stacked with great heaps of pipes for sewerage and drainage purposes. But the broken pottery is even more aggressive than the sound ware. Every "grotto," or "rockery," is made of it; every garden path is edged with it, or with fused fire bricks. The mounds of refuse adjacent to the works are continually extending their borders and spreading over the country.

In this way, the green turf of Gresley Common is being slowly hidden from view. The collieries, too, are knocking at the door of Gresley Church. The ancient little building is overshadowed by the pit-head gear, and coal waggons are running by its windows. In these parts, it seems that modern industry, in its hasty march towards better things, has no time to clear up the disorder that is created by its methods of progression. After passing Swadlincote and Woodville, the top of a hill is reached, 569 feet above the sea level. Cornfields and meadows abound on either side, and there is also the magnificent landscape of Charnwood Forest. Then comes the hamlet of Boundary, so called, as it is a boundary of shires, parishes, and manors. Close by, is the notable village of Smisby, set amongst fine park-like scenery.

It can still boast of its tournament field, which Sir Walter Scott made allusion to in "Ivanhoe." The situation is very exposed at Boundary; severe storms rage there periodically, and the inhabitants say that anyone who can live winter and summer at Boundary, could live anywhere. After entering Leicestershire, the new line makes a quick descent into Ashby-de-la-Zouch. The old town has the refined air of a fashionable inland watering-place, though its medicinal saline baths are not more than a century old. The fourteenth-century castle was wrecked during the seventeenth-century civil wars; but even the portions that remain are magnificent, alike in size, strength and beauty of architecture.

The old church hard by, has a fine tower and some interesting relics inside, including a remarkable set of finger stocks. Roger la Zouch became lord of the manor in 1219, and, while the family remained in possession of it, Ashby was a great centre of chivalrous and knightly games, over which Sir Walter has cast the inextinguishable glamour of romance in his great novel.

The last of the Zouches, one Alan, fought at Cressy. Lord Hastings, to whom the property afterwards came, was beheaded by the Duke of Gloucester before he became Richard III. Mary Queen of Scots was imprisoned a few weeks at Ashby Castle, and James I. was entertained there.

The power station and car shed have been built at Swadlincote, which is about midway between Burton and Ashby. These premises are designed to give every facility for convenient and economical working, with ample margins for any extensions that may be necessary in future. The shed has six lines of rails, and underneath there are pits about 4 feet deep, like a railway

engine shed, so that the motor machinery on the cars may be easily got at for the purpose of examination and repairs. Adjacent to the car-shed, is the spacious and well-equipped power station. Here we find that not only is steam out of date for light locomotive purpose, on a short track, but it is also being superseded as a prime mover for the generation of electricity; at any rate, in comparatively small and insulated stations, where a varying and not very heavy load has to be dealt with.

Steam plant is, of course, expensive to install and maintain, owing to the necessity for boilers; and unless these are worked constantly, and at full power, there must be a lot of steam and fuel wasted. The alternatives are gas or oil engines. Where gas can be obtained from town mains, a gas engine is always ready for work; but it is usually cheaper for the consumer to produce gas on the spot from low grade fuel. In the case of oil engines, neither boilers nor producers are necessary; therefore, no stokers are required, and the engines can be started at a few minutes' notice without any preliminaries worth mentioning.

Swadlincote is in the centre of a colliery district, where there is an abundance of cheap coal, yet, instead of using this, it has been found better to instal Diesel engines, which will use crude petroleum, imported from various parts of the world. In ordinary gas or oil engines, the explosion which drives the piston is caused by a gas jet, or an electric spark, or a red-hot tube being applied to an explosive mixture of gas and air in the engine cylinder; but the Diesel engine has a novel arrangement, by which there is highly compressed air in the engine cylinder, and also a separate supply in a reservoir. The compression of the air, of course, increases its temperature very much; in fact, its heat is sufficient to cause the combustion of oil when the latter is injected as a fine spray into the engine cylinder. The high pressure air in the reservoir works a suitable device, which pulverises the oil by forcing it through a number of small holes into the compressed air behind the piston. Instead of a sudden and violent explosion, there is a gradual burning of the oil, accompanied by a gradual rise in the pressure of the cylinder; a more equable movement of the crank shaft is thus obtained; and in this respect, the action of the Diesel engine resembles that of the best steam engines rather than ordinary oil motors. The Diesel engine only requires about half-a-pound of oil per brake horse-power per hour when working at full load.

There are two three-cylinder vertical engines of 240 B. H.-p., each with a huge fly-wheel weighing about nine tons, coupled direct to two cylinders, each capable of giving an output of 150 kilowatts.

Briefly speaking, the cars with open tops are of the usual pattern, with all the latest possible improvements, and were built at the Brush Electrical Company's Works, Loughborough.

They bear the Midland Railway Company's coat-of-arms, and are designed to carry 57 passengers each, 22 inside and 35 outside. They are mounted on Brush rigid wheel base trucks, with steel tyred wheels, provided with Hudson-Bowring lifeguards, and magnetic track brakes. The electrical equipments, powerful motors, etc., were furnished by the British Westinghouse Electric Manufacturing Company, of Trafford Park, Manchester. Accommodation has been provided for the carrying of a limited number of parcels on the platforms of the cars, while, at a later stage, it is intended to carry booked parcels. Workmen's cars, with special fares, will be run as soon after the formal opening of the line as possible.

The following particulars regarding the car service, will bear comparison with the service at present in force on the existing Ashby and Burton branch line :

Between Ashby, Swadlincote, and Burton, every half-hour.

Between Woodville, Swadlincote, Newhall, and Gresley, every 15 minutes.

Ordinary service commences at 8 a. m.

Passengers between Ashby and Gresley change at Swadlincote Market Place or Woodhouse Road.

The estimated cost of construction, together with the purchase of lands, is £150,000. A first and successful trial trip was made, prior to the formal opening in June, and by the time this article is in print a great boon will have been conferred on the 100,000 inhabitants of the various villages and towns through which the line passes.

Mr. Chas H. Gadsby, is the consulting engineer of the railway.

Thanks are due to Mr. James Toulmin, A. M. I. E. E., the local manager and engineer of the Burton and Ashby Light Railway, for information for this article.

## ROARING RAILS.

---

### A MYSTERIOUS DEVELOPMENT.

By G. MOYLE,

ENGINEER IN CHIEF, EASTERN BENGAL STATE RAILWAY.

---

Figs. 1 to 6, pp. 1501 and 1502.

---

(*Page's Weekly.*)

---

The above term originated on the Eastern Bengal State Railway some ten years ago. "Roaring" may be defined as the noise caused by the development of furrows across the running head of a rail, usually oblique to its length, the tops of the furrows being very hard and the bottoms soft. Such rails are also described as "corrugated." They do not in the least resemble galled or pitted rails.

The common objection to these rails is, that they occasion a deafening noise when trains are passing over them, which causes great discomfort to passengers. To give an impression of how objectionable the noise is, it may be stated that two persons, inspecting the line by light trolley, cannot possibly converse, even by shouts, when running over a continuous section of these rails. However, there is still more important and serious objection, which will be referred to below.

The engineers of Indian railways have had roaring rails under observation for the past eight years, but up to the present, no definite conclusion has been formed on the real cause of the phenomenon, and no manufacture-specification has been drawn up with a view to produce a metal likely to be exempt from its development. This paper is written for the express purpose of bringing the phenomenon to the notice of railway experts, with the hope that a remedy for it may be discovered.

The mean pitch of the corrugations has been found to be 0.74 inch, and the mean depth 0.0035 inch. The following are the principal ascertained facts concerning the phenomenon :

Both double-headed and flat-footed rails develop it; it is not confined to any particular weight or section, or to double or single line. It develops in rails rolled by various manufacturers. It

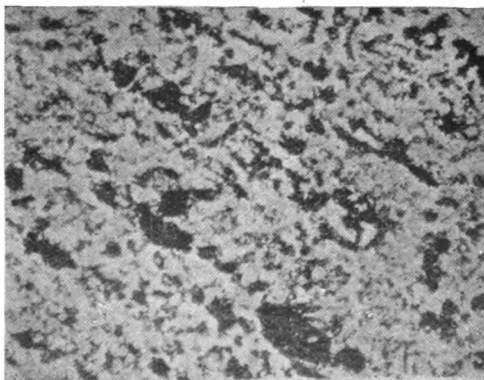


Fig. 4.  
Rail 2020. Depression on running head.

The white portions appear to be ferrite, but at a higher magnification are found to be entirely laminated pearlite.

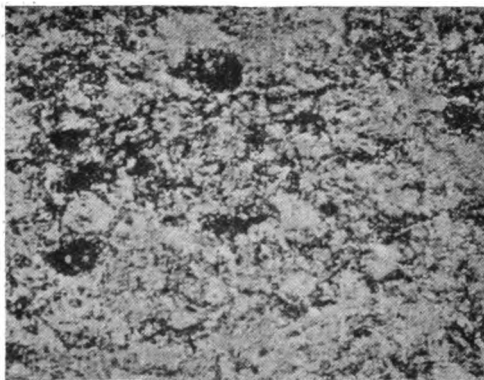


Fig. 2.  
Rail 2020. Elevation in running head.

The white portions appear to be ferrite, but at a higher magnification are found to be almost entirely laminated pearlite.

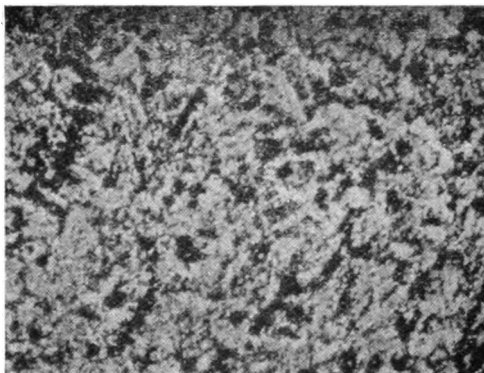
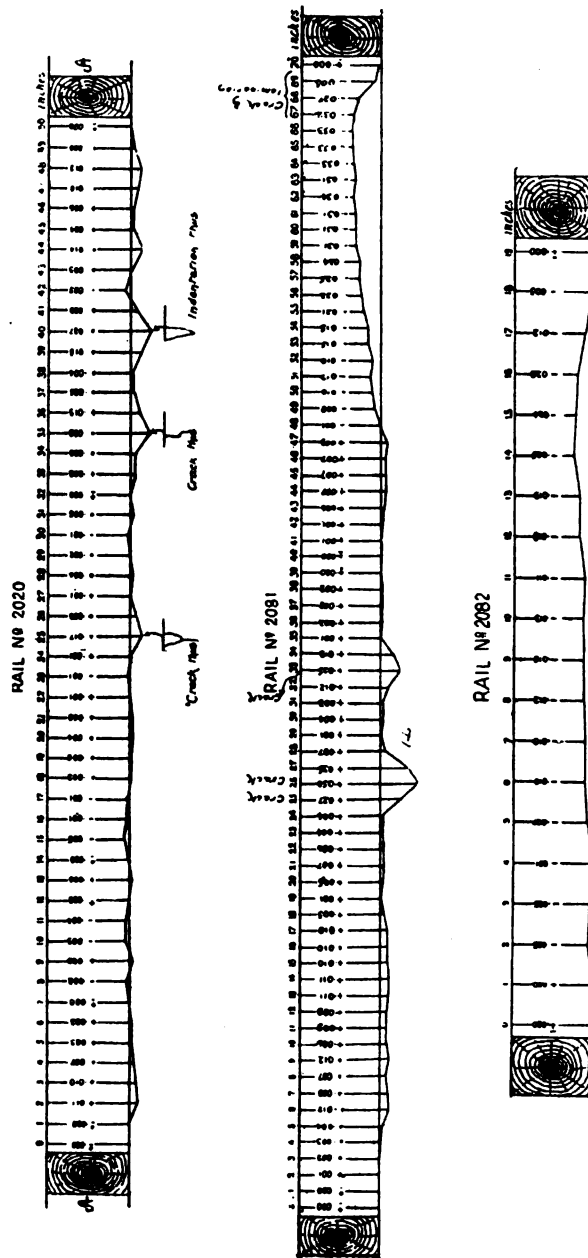


Fig. 3.  
Rail 2020. Inside of raised portion of head.

shown to be very finely laminated pearlite.



Figs. 4 to 6.

Packing pieces AA exactly 1 inch thick were placed on the rail-head, and on these a true straight edge, Measurements were taken by a vernier gauge between the straight edge and rail-head at intervals of 1 inch. The sign + denotes the depressions below the datum line, and the sign - elevations above the datum line. The elevations and depressions are shown ten times greater than they actually measured.

develops with equal facility on banks or cuttings, grades or levels, straights or curves. It appears to be found more generally in extremely damp climates, especially when the atmosphere contains salt brought from the sea; but it is found in a variety of climates, and even in exceptionally dry inland tracts. It develops most rapidly where brakes are freely used; for instance, just outside and inside station signals; but it is not necessarily produced by brake action, since it exists abundantly in parts of tracks where brakes are never put down. Cases are common in which a roarer occurs, while the rails fished to it or immediately opposite it in the track, though delivered by the same manufacturer in the same year, do not roar. Roarers taken out of the track, planed smooth, and replaced, have again developed roaring. Roarers almost invariably develop where the track is packed and boxed with brick or burntclay ballast, and on open girder bridges. Roarers are scarcely ever found where the ballast is stone, and never where the track is packed and boxed with earth. Roarers on brick-ballasted road can be got smooth if the brick boxing is removed and replaced by earth: the trains then wear the rails smooth; it is not necessary to remove the brick-ballast packing under the sleepers. Roaring has only been found in steel rails, and never in an iron rail; one lot of steel double-headed 73-lb. rails delivered about 1880-1882, have never developed roaring though packed and boxed with brick-ballast, and subjected to the same conditions which have a tended roaring in adjacent rails.

Roarers have been cut into thin slices, both parallel and at right angles to the vertical axis. The ridges of a roaring rail resist a file, but the metal in the hollows is removed quite easily. It has been found dangerous to reverse double-headed roarers in the track, *i. e.*, to place them upside down, as they have been found to fracture; it is also undesirable to change the position of sleepers under flat-footed roarers, this also leads to fracture. So far as roaring rails have been examined by experts, their opinion is that there is nothing in the chemical composition, physical condition, or microscopic structure to explain the phenomenon.

The following are amongst the causes of roaring suggested by various engineers: To vibrations set up in some unknown manner on an imperfectly packed road in a yielding formation, and that once this cause is removed and the vibration arrested, the effect will also be eliminated, and the wear become even. To portions of the rail rusting away under the action of dew, and leaving ridges, the cause of this being want of homogeneity in the metal. To rails after rolling being stacked whilst hot in layers crossing each other at right angles, so that unequal cooling is produced, the surface being annealed locally and at uneven intervals. To accidental irregular cooling after rolling. To the ingots from which the rails were rolled being cooler than they should have been. To the effect of brakes which lift the wheels from the rails; when this happens, the brake ceases to act and the wheel falls down on the rails; the brake begins to act again, and so on, the flexibility of the springs accentuating this undulatory motion. To wheels being braked with maximum retarding force, which is just short of skidding: that is to say, by a force on tyres rather less than the weight of the vehicles on the rails; this is brought about by a vibratory action set up in bearing springs by the jolts occasioned in passing over the joints. To excess of manganese in the metal. To the existence of alternating lenticular masses of pearlite and ferrite. To the rails being finished from the rolls at an improper temperature.

To give an idea of the extent to which roaring can develop under favourable conditions, it may be stated that in a section of metre-gauge single track on the Eastern Bengal State Railway between Dacca and Mymensingh, 12  $\frac{1}{2}$  continuous miles of which were very carefully inspected, all roarers and non-roarers being counted, it was found that 89 per cent of the rails were roarers.

The traffic in this section is light, the speed slow, and the track maintenance excellent. No continuous brake is, or ever has been, used. On the other hand, the section examined is brick ballasted, the climate is extremely moist, the rainfall excessive, and the atmosphere is said to be charged with salts.

The following is a note on a piece cut from a typical rail taken out of the above nest of roarers :  
“ Measurement of depth and pitch of all the corrugations in a piece of roaring rail from the Dacca section, Eastern Bengal State Railway (41  $\frac{1}{4}$  lb. steel flat-footed) :

34·54 inches long.

Depth of corrugations : Maximum, 0·0068 inch ; minimum, 0·0011 inch ; mean, 0·0035 inch.

Pitch of corrugations : Maximum, 1·14 inch ; minimum, 0·50 inch ; mean, 0·74 inch.

There appears to be no relation between pitch and depth, but generally greater depth goes with greater pitch.

An extract from an official report made in January, 1902, is given below :

A roaring rail was found fractured on the line, between Chogdah and Ranaghat, Eastern Bengal State Railway, on December 26, 1901. (This line is double track laid with steel 73-lb. double-headed rails.) The permanent-way inspector had reversed this rail a few days before its fracture, and it is thought that there can be no doubt that this caused the fracture, and that the reversal or turning upside down of steel rails is a dangerous practice. Two pieces of this rail have been kept, so that they may be sent to England for thorough examination and report. The original head of the rail, which shows the alternations of hard and soft metal which are characteristic of roaring rails, displays unmistakable skin cracks across the head at the places where the soft metal exists, and apparently fracture has occurred through one of these skin cracks. As far as is known, these skin cracks are not generally noticeable in roaring rails ; but it is quite possible that they exist, and that microscopic examination would have discovered them.

If skin cracks are general in roaring rails, there can be no doubt that they constitute a serious defect.

The two pieces of this rail were forwarded to England for examination, and one piece, together with two other pieces of rail sent to England on former occasions, were examined in the laboratory of the Royal Indian Engineering College, Cooper's Hill.

The following is the report submitted from that laboratory ; and it should be noted that No. 2020 is the roaring rail which fractured :

“ I have very carefully examined the three rails submitted to me, and neither from the chemical composition, physical condition, nor microscopic structure, can find anything to explain the phenomena, and I feel convinced that the unevenness of the surface which is responsible for the roaring is not due to the chemical composition or physical state of the rail, but to some local cause. The following are the results of the analyses. In the case of No. 2020 samples were taken from both ends of the rails, but no appreciable difference was found in the analyses :

No. 2020. Roaring Rail. Referred to in letter March 15, 1902, No. 418 M. S., Eastern Bengal State Railway, marked 000 : Carbon, 0·691 ; silicon, 0·148 ; sulphur, 0·067 ; phosphorus, 0·078 ; manganese, 2·090 ;

No. 2081. Roaring Rail. Marked Steel I. S. R. 73 lb. IX., 1885, B. and Co. : Carbon, 0·472 ; silicon, 0·052 ; sulphur, 0·124 ; phosphorus, 0·100 ; manganese, 1·050 ;

No. 2082. Worn Rail. Marked 43285, December 18, 1901, sent for comparison : Carbon, 0·459; silicon, 0·569; sulphur, 0·076; phosphorus, 0·058; manganese, 0·950.

“ Rail 2020 is quite abnormal, containing over 2·00 per cent of manganese. It was extremely hard, and could only be sawn up with the greatest difficulty, and cracks in numerous places extended into the running head to a depth of  $\frac{1}{2}$  inch under high powers of the microscope (1,500 diametres), the structure is almost entirely pearlite, there being little or practically no ferrite, which is what one might expect from the percentage of carbon. The other rails were fairly normal as regards composition, except the high silicon in No. 2082, and both these give normal micro-structures of ferrite and pearlite. No. 2020 under the low power, 150 diametres, appears to consist of ferrite and pearlite, but at a higher power this is not the case. Enclosed are diagrams showing the depths of corrugations on the surfaces of each running head, and it will be seen that these are most irregular. A suggestion was made in the correspondence that the uneven wear of the rails might be due to alternating patches of ferrite and pearlite, the soft ferrite being more readily worn away than the pearlite; but when it is remembered that the ferrite areas are microscopic and never exceed  $\frac{1}{100}$  of a square inch in any of the rails, the impossibility of having alternating patches an inch or more in length will be fully realized. From the abnormally high carbon and manganese and hardness of rail 2020, it might be assumed that the roaring was due to this, but this assumption is at once negatived by the composition of of rail 2081, which is a fairly soft normal rail, and behaves in the same way. Consequently, the only conclusion to be drawn appears to be that the roaring is not due to any peculiarity in the rail itself.”

The Board of Trade, England, some fourteen years ago, appointed a committee to inquire into the loss of strength in steel rails through use on railways. Their report was published as a Parliamentary Blue-book in 1900, and the following extract is taken from page 71, as it may possibly throw some light on the subject of this paper :

“ Another important point illustrated by these results is the influence exerted on the character of atmospheric corrosion by the unequal distribution of iron and carbide of iron in the rail, which is particularly marked in the presence of much manganese. When, owing to the method of annealing and other processes to which the steel is subjected during manufacture, the iron is deposited in large veins and laminæ, the micro-photographs appear to show that these are eaten out by atmospheric corrosion forming superficial furrows, the extent and significance of which remain to be determined by further experiments. So far as the evidence goes at present, it appears that while they probably lead to increased loss by wear and tear, there is no proof that they are starting points for fractures in the rails.”

From the concluding words of the extract given in the preceding paragraph, it would appear that it was suspected in 1890 that skin cracks might exist in furrowed or corrugated rails, and the report on rail No. 2020 now confirms this suspicion; though in the case of that rail, the excess of carbon might account for them.

The only important fact evolved from the examination of the rails at Cooper's Hill, is that the roaring rails contained an excess of manganese. This has been put forward as the cause, *vide* paragraph above.

The locomotive superintendent, Burma Railways, wrote as follows in 1899 :

“ I, however, hazard an opinion that the mischief will be found to be confined to the

steel made in the early eighties of the expiring century, all of which has an excess of manganese."

This opinion rather conflicts with what is stated above, but this may be accidental.

It is considered by engineers on Indian railways that the results of investigation, so far as they have gone, are extremely meagre and unsatisfactory, and that it is important to ascertain and remove the initial causes of this mysterious development in steel rails. It is to be regretted that no laboratory exists in India where independent and constant investigations might be made.

## AUTOMATIC SIGNALLING ON THE UNDERGROUND RAILWAYS OF LONDON.

Figs. 1 to 19, pp. 1513 to 1520.

*Engineering.*

The signal arrangements adopted in connection with the electrification of the District Railway, play a very prominent part in the economy of the scheme. In fact, no good results could be obtained, nor could a return for the financial outlay be secured, except by the adoption of improved methods of signal operation. The acceleration of the train service, brought about by the introduction of electric traction and the quicker reversal of trains in terminal stations, would have been of little avail under the signalling conditions formerly existing, as the old train service was practically all that the line could then carry.

Having decided upon a 1 1/2-minute service as the object to be achieved, the Underground Electric Railways Company of London, who undertook the electrification of the line, at once recognised that the usual form of manually-operated signals, with an establishment of signal cabins and a staff of signalmen, was not only impracticable from the physical conditions of the line, but altogether prohibitive from the point of view of capital outlay and the cost of up-keep and operation. An alternative was, however, to be found in automatic signalling.

While the signalling automatically of a steam-worked railway, by means of track-circuits, is a simple matter, it is a very different problem on a line equipped for electric traction, owing to the possibility of extraneous currents from the motive power interfering with the signal circuits. Further, the company had determined that the conditions absolutely forbade anything of an experimental nature being tried. Some two years previously — in 1900 — the first electric railway to be equipped with automatic signals, controlled by track-circuits, had been successfully brought into operation. This was the Elevated Railway of Boston, U. S. A., and the work had been carried out by the Union Switch and Signal Company, of Swissvale, Pa. (a Westinghouse firm). Here Westinghouse electric-pneumatic signals were, owing to their simplicity and reliability, deliberately chosen and installed, rather than purely electric signals, and the many difficulties connected with the problem were ingeniously overcome. It was, therefore, but natural that the experience there gained should lead to the choice of a similar system on this side.

It will be remembered that the (then) unopened Ealing and Harrow branch was the trial place used by the Underground Electric Company for their electric traction experiments, and the Westinghouse Brake Company, of 82, York-road, King's-cross, London, undertook to equip this line with automatic signals controlled by track-circuits, as had been done in Boston. They were

successful in securing the services of the, then, signal engineer of the Boston Elevated Railway — Mr. H. G. Brown — to superintend the installation on the Ealing and Harrow line, and a patented improvement of his, which ensured a far greater degree of safety than had hitherto been attained, was introduced. The branch was opened in June, 1903, and the signal arrangements were found so satisfactory that, after tenders had been solicited from other signalling firms, the Westinghouse Brake Company was awarded the contract for equipping the whole of the District Railway. The same system has been adopted on the Baker-street and Waterloo line, and the Great Northern, Piccadilly, and Brompton Railway will be similarly equipped, while a smaller installation is also in work on the electrified portion of the Lancashire & Yorkshire Railway.

The special arrangement of track-circuits employed will be fully described later, but it may here be said that one of the running rails is divided up into block sections by means of insulated fish-plates, and the other is electrically continuous. A difference of potential of from 2 to 4 volts is maintained between these two rails. At each end of the block section, a polarised relay is connected by one terminal to the block rail, and by the other terminal to the continuously bonded running rail. The local signal-circuit is controlled by both relays, and unless they are both suitably energised by a current in the normal direction, the signal cannot drop to "Clear." The entrance of a vehicle into the block section short-circuits one or both of the relays, and the signal is placed at "Danger," and remains so as long as the vehicle is in the section.

The main feature of this installation (Brown's patent) is that currents extraneous to the signal system cannot affect the apparatus so as to cause a false indication of safety. When a train is in the section, one or other of the relays is always reversely energised or shunted, thus opening the local signal-circuit at one or two points.

As indicative of the economies effected in signal-boxes, and the consequent establishment of signalmen and upkeep of the cabins, it is interesting to note that formerly there were between South Kensington and Minories Junction (but exclusive of those stations) thirteen signal-cabins, and now there is only one at the Mansion House and an emergency one at St. James' Park. Then, as showing the value of automatic signals for increasing the carrying power, it may be observed that the service between the Mansion House and South Kensington stations has been increased, and, when this is complete, there will be at the "rush" hours at least forty trains per hour. The services west of South Kensington — to Harrow, Ealing, Hounslow, Richmond, and Wimbledon — have been similarly improved.

Whilst the majority of the signal-cabins have been swept away, as already explained, twenty nine still remain; but of these, five are emergency-boxes, and are only opened occasionally to work cross-overs or siding connections, should irregularities in the traffic demand this. Thirteen of the remaining twenty-four have been equipped with the Westinghouse electric-pneumatic apparatus for operating points and signals by compressed air. By this method of working, the manipulation of the points simply calls for the movement of a small lever by the signalsman, whose labours are no longer exhaustive, but are reduced to a minimum, and consequently he can devote his mind more closely to the safe movement of the trains. As the locking-frame takes up less room, the sizes of the signal-cabins are considerably reduced, and, further, they may, if necessary, be placed in positions that are insuitable and impracticable for the ordinary signal-box. Lastly, as the Board of Trade permit their requirements, as to the maximum distance that facing-points may be worked from a signal-cabin, to be extended in favour of points actuated by power, it is possible not only to lay out a station or yard to greater advantage, but to bring within the range of one cabin the connections that would call for two cabins were the points connected to

mechanically-operated signal-frames. Examples of such economy are to be found on the District Railway, notably at Cromwell curve, where one power signal-box does the work of the three mechanical ones that previously existed. A signal cabin has been stated at West Kensington (where it would ordinarily have been necessary to provide two), and at Mill Hill Park the yard is so laid out that, whilst the work is all accomplished by means of one power-operated frame, two would have been necessary had the signalling been on mechanically-operated methods.

In those cases, where the old locking-frames remain and the points continue to be worked by manual power, the signals are not coupled to the usual signal-wires, but are actuated by power, the controlling current for which is switched on by means of contacts on the signal-levers in the locking-frame. There are, therefore, no wires to adjust, and the signals come "off" to the correct angle and go to "Danger" properly. All the signals on the line are therefore actuated by power, this power being air compressed to a pressure of 65 to 70 lb. The whole of the line, including most sidings, is track-circuited, the length so controlled being equivalent to about 57 miles of single track. All signals at interlockings — *i. e.*, those operated from signal-cabins — are controlled by the track-circuits, and are technically known, therefore, as semi-automatic. Where necessary, running signals — *i. e.*, those governing the running of trains on the main line — have their respective levers in the locking-frame controlled by the track-circuit for the line or lines they protect, so that whilst the signalman can put the lever sufficiently far back to replace the signal to the "Danger" position, he cannot put it fully back, until the train has gone over the portion of the line protected by the signal. The signal lever, not being fully back, "holds the road," and prevents the signalman from inadvertently pulling over the levers of conflicting points and signals. At interlockings, the signals are automatically restored to "Danger" by the train, independently of the action of the signalman; but he must replace the signal lever in the locking frame to normal before the signal can be again lowered to "Safety." Fouling points on sidings and on diverging and converging lines are protected by the track-circuit, so as to guard against any train or vehicle standing foul.

The average length of the block sections through the tunnels (eastward of South Kensington) is 900 feet. On other parts of the line the lengths vary from 900 to 4,000 feet. Each signal is governed by the section immediately in advance of it, and this section commences 400 feet beyond the signal, and extends to 400 feet beyond the next stop signal. This distance of 400 feet is known as the "overlap," and a signal cannot be lowered until the whole of the preceding train has gone out of the section in advance, and has also passed the next signal by 400 feet. The purpose of this arrangement is to guard against a collision caused by a signal being passed at "Danger," as the provision of an overlap affords an additional space in which to pull up in case a signal is so passed. A further safeguard is an automatic train-stop, as illustrated by figure 1. The stop is seen by the side of the "off" running rail, and when standing up, as illustrated, it strikes the handle of a special valve on the leading motor-car, which applies the continuous brake, and pulls up the train. When the signal is lowered, an electro-pneumatic valve (which is operated co-incidentally with the signal) admits compressed air to the cylinder on the right, so that the rod is driven from right to left, the rocking-shaft is turned, and the stop is lowered. When the signal is restored to "Danger," the valve on the cylinder is opened, the air escapes, and the stop again rises, being assisted by the spring on the rod. A test was made, and it was found that a seven-car train, when running at full speed on a down grade of 1 in 460, was pulled up by the train-stop in 218 feet, or little more than half its own length. As the automatic-stop equipment on the cars is of vital importance, it is regularly and carefully inspected before each journey is commenced, also sometimes *en route*, as, for instance, at

St. James's Park Station. It may here be mentioned that a motorman is empowered to pass a signal at "Danger" after waiting one minute, and to proceed cautiously throughout the entire section providing he has reason to believe that the signal is not being legitimately held at "Danger" by a train.

As a rule, there are no distant signals; every signal, therefore, is a stop signal. The signals, except those actuated from signal-cabins, stand normally "off." With such a frequent service, had the "normal danger" position been adopted, the signals would necessarily have had to stand longer in the "Clear" than in the "Danger" position. An automatic signal, being simply an indicator as to the state of the block section, and not a substitute for the verbal instructions of a signalman as to whether a train must stop or may proceed — which is what a non-automatic signal really is — should surely stand at "Clear" when the section is clear. Further, the normal "Clear" position presents the advantage of showing more readily whether the signals are working properly.

In the open country, semaphore signals of the ordinary pattern are used. Those on the District Railway, however, have corrugated steel arms A. The spindle for the arm, the lamp-bracket, and the motor are all carried by one casting, which can be secured to a post or wall by four bolts — a good example of compactness.

In the tunnels the signal shown in figure 2 is used. When at "Danger" it is as illustrated, with the upper spectacle (red) of the screen before the lamp; but when the signal is cleared, air is admitted to the cylinder inside the box casting, and the screen is raised so that the green spectacle appears before the lamp. In order to place the signal at "Danger," the air is released, and the screen falls owing to its weight.

For sidings and shunting movements generally, the dwarf signal (illustrated by fig. 3) is used. The air cylinder is in the base, and is connected to the arm by a rod in the pillar. The arm is normally locked, so that it cannot be pushed off by anyone on the ground. The signals are lighted by gas, and each is supplied with an Adlake long-burning oil-lamp, for use in case the gas fails. This lamp will burn for a week continuously without any attention.

The principle of the selection of signals has been fully adopted; that is to say, conflicting signals are divided into groups, and each group is controlled by one lever. The selection of each signal in a group is dependent on the position of the points.

Points, like the signals, are also operated by compressed air. Facing and trailing points are provided with a motor similar to that shown in figure 4. Points, however, differ from signals, inasmuch as they require power not only to change them from "normal" to "reserve," but to restore them to "normal." In the case of facing-points, the switches, plunger, and locking-bar are all operated by one motor. This motor moves the bar first, the bar moves the plunger, and frees the points; then the points, being moved over, are again locked by the plunger; but this cannot occur unless they are in their correct position. The last movement — i. e., the shooting of the plunger into the new position of the point-tongues — completes the operation; and this is indicated to the signalman by means of the closing of the appropriate contacts in the indication-box. If, therefore, the points are not properly over and bolted, or are over and not bolted, the return indication cannot be given. Until this return indication has been received in the cabin, the stroke of the point-lever cannot be completed, and the signalman is thereby made aware that the points have not properly responded to the movement of his lever.

It may conveniently here be stated that the Underground Electric Railways Company have provided special boxing over their facing pointlocks, so constructed that the pieces dovetail and interlock with each other, so that they cannot come loose by accident. Attention may here also

be drawn to the flexible hose used for connecting the point-motor to the air-main. This allows of the sleepers on which the motor is fixed being lifted and slewed at pleasure, which could not be readily done if the air connection were a rigid one. Figure 6 is a view of a trailing-point lay-out, and here it will be noticed that the indication-box is coupled directly to the points. The pull-rod is led from the motor to the further tongue, but the indication is coupled to the near one. This ensures that the stretcher-rods between the tongues are intact, and that both tongues have responded to the movement of the motor; and unless this takes place, the return indication cannot be given.

Electro-pneumatically actuated scotch-blocks are used in some places — *e. g.*, in the sidings at Earl's Court, where one siding has to be protected against another.

Coming now to a description of the locking-frame, it is assumed that the readers of this article are acquainted with the general principle of the electro-pneumatic frame. Such a locking-frame is illustrated in figure 7, which is a view of the interior of Earl's Court East signal-cabin. The miniature levers will be appreciated, and therefrom one can readily understand the great difference between the labours of a signalman employed in such a cabin and in one where the points and signals are actuated by the usual means of rods and wires. The interlocking is on the tappet principle, the bars being arranged vertically. Attached to the levers in the rear are the electrical connections whereby the admission of air to the point and signal motors is controlled; and there also the return indications are to be found. For the information of those who are unacquainted with the electro-pneumatic machine, it may be stated that when a point-lever has to be moved — either from normal, forwards, or from reverse, backwards — a lock on the lever will not allow its full movement to be at once obtained. The first portion of the stroke simply sets up the electrical circuit to the air-valves of the points, admitting air to the motor. When the work has been completed, the return indication is given (as has already been described) by the completion of another circuit, which takes out the lock holding the lever. This allows the signalman to complete the stroke. This pause, however, is only momentary as the whole operation can be completed within two seconds. Signal-levers are practically controlled in a similar manner, except that it is not considered necessary to hold the lever when pulling the signal "off," as no harm could happen should the signal fail to come "off" in response to the movement of the lever. But it is an altogether different matter when a signal has to be restored to "Danger;" consequently a signal lever cannot be put fully back at one stroke, but a pause has to be made to allow for the return indication to be received, showing that the signal has actually returned to the "Danger" position. Incidentally, it may be remarked that as the signals on the District Railway are thrown to "Danger" automatically by the train controlling the track circuit, they are generally already at "Danger" when the signalman replaces his lever, and therefore he can put it fully back in one stroke. It is by a similar lock that signal-levers at interlockings are held so long as a train is travelling over the junction and siding connections protected by such signals as were referred to above in connection with signals. It will then be understood how impracticable it is for failures to occur in the movements of points and signals without such being immediately detected, and how safety is secured by the lever being locked up. The mechanical interlocking prevents signals being lowered until the corresponding points are in position, which is attained by the point-levers having first to be placed in their proper positions. If then, the point-levers are not over (or back) — which can be only after the return indication has been received — the signals cannot be lowered, and, therefore, the approaching train is kept back. Similarly, if a signal fails to go to "Danger," its lever cannot be put fully back, and so the road is held. The compactness of the electro-pneumatic machine

will be appreciated when it is stated that the frame in Earl's Court East cabin is 3 ft. 11  $\frac{1}{2}$  in. high, 4 feet wide, and 6 ft. 1  $\frac{1}{2}$  in. in length; it contains twenty-seven lever spaces, made up as follows :

- 10 levers working 23 signals.
- 9 levers working 16 points, 6 facing-point locks and bars.
- 2 levers giving permission to Earl's Court West.
- 2 levers controlled from Earl's Court West.

- 
- 23 working levers.
  - 4 square spaces.

- 
- 27-lever frame.

The permission and control levers prevent conflicting movements being made at the two ends of Earl's Court Station.

Special attention has been paid to the wiring in the signal-cabins. Each wire is ready of access and is labelled. It is all done like telephone exchange work, as may be seen in figure 8 showing the arrangement of wiring and relays at South Kensington.

The lower wires are those connecting the locking-frame to the various points and signals, while the relays shown above the wires are those required for the electrical interlocking between the track circuits and levers; they also control the illuminated diagram. In the background are to be seen the signal switchboard and accumulators.

The power for the traction of the trains on the Metropolitan District, Baker-Street and Waterloo, Great Northern, Piccadilly and Brompton, and the Charing Cross and Hampstead Railways, is generated on the banks of the Thames, at Lots-road, Chelsea. This enormous station is the largest electrical power station in the world, and is designed to supply some 44,000 kilowatts of three-phase current at a pressure of 11,000 volts and a frequency of 33  $\frac{1}{3}$  periods.

From Lots-road, the feeders for the Metropolitan District Railway run underground to Earl's Court, and thence feed the eleven sub-stations situated on this line. At each sub-station the current is transformed by means of static transformers to a pressure of about 400 volts; this is again transformed by rotary converters to direct current at 600 volts pressure. The direct current is fed to an insulated third rail, placed outside the running rail, whence it is picked up by means of shoes on the motor-cars. After energising the motors, the current passes by means of other shoes on to a fourth insulated rail in the 4 feet way, and thus back to the sub-station.

A map of the line, showing the power-station, sub-stations, and signal-cabins, is given in Figure 9. At each of the eleven sub-stations motor generators (in duplicate) furnish the current at 60 volts for the signal system. The negative main of the signal system runs the whole length of the line, and 60 volts is maintained between the positive power rail and the negative signal main. This supplies power for the track-circuits, charging the accumulators at the power-worked interlockings, and working all relays, special circuits, and all other purposes connected with the signalling. The power required for track-circuit purposes is 0.3 kilowatt per mile of single track. An idea as to the total power required for signalling can be obtained from the fact that the power required for the lighting of a seven-car train on the District Railway would signal eight miles of double track, including the power required for compressing the air used for operating the signals and points.

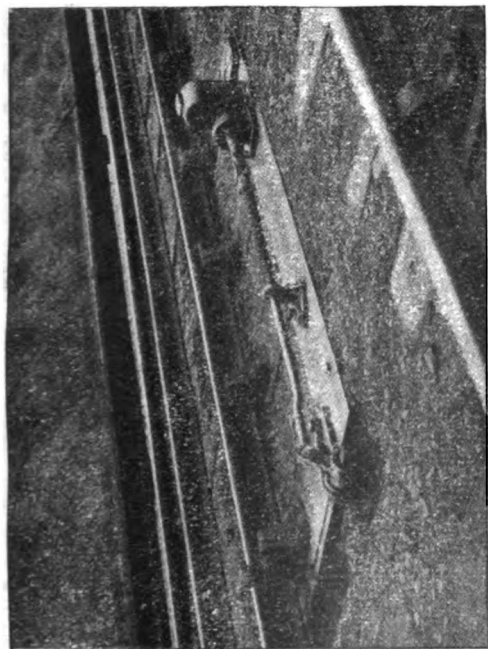


Fig. 1. — Electro-pneumatic train-stop.

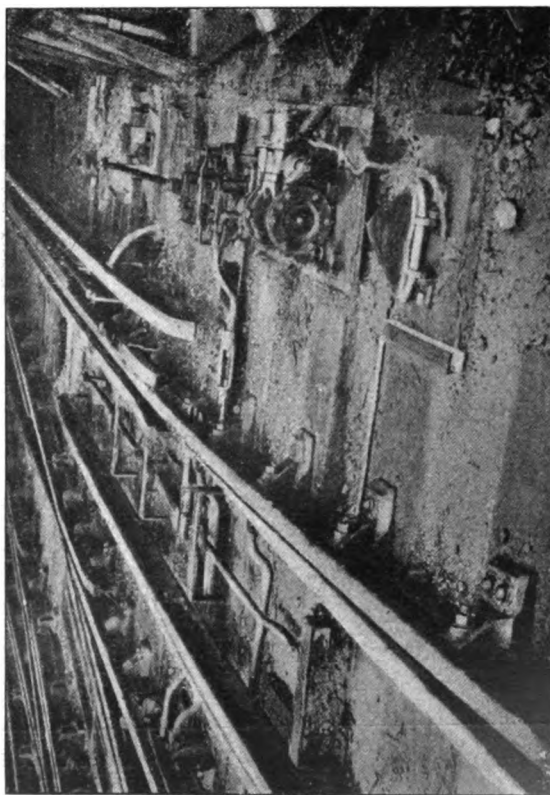


Fig. 5. — Electro-pneumatic facing-point lay-out.

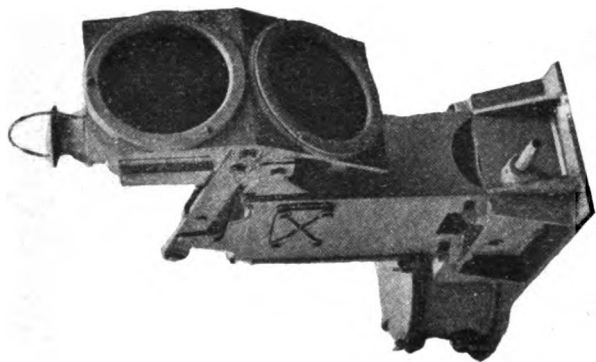


Fig. 2. — Signal in tunnel.

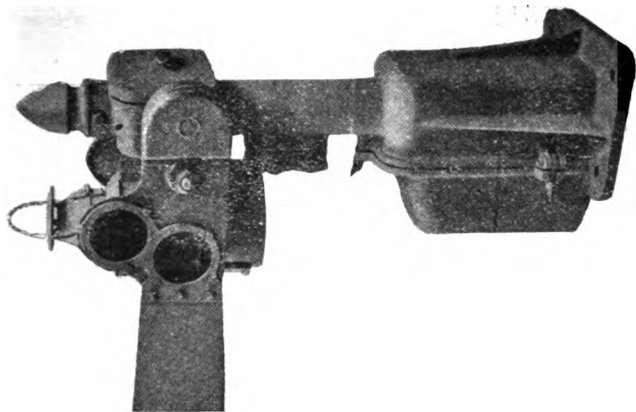


Fig. 3. — Dwarf signal for sidings.

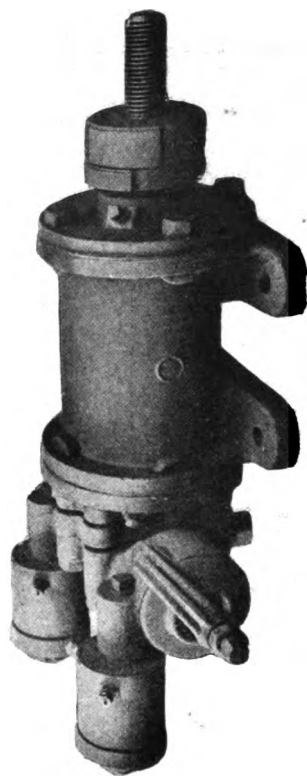


Fig. 4. — Motor for actuating points.

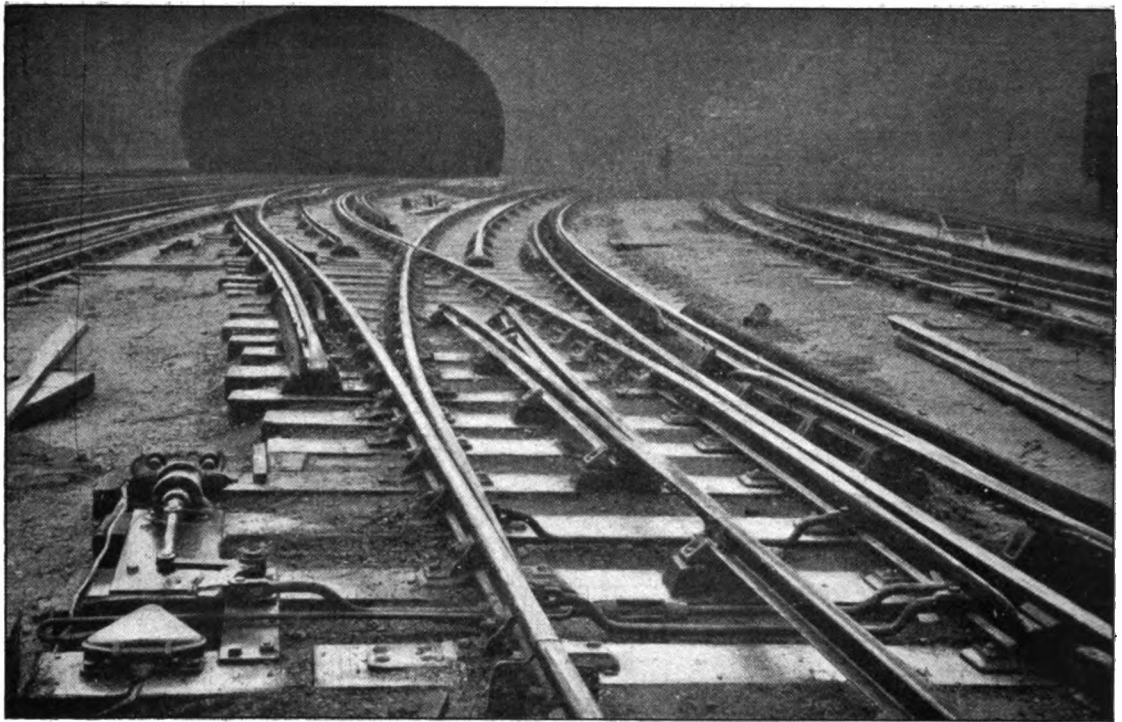


Fig. 6. — Electro-pneumatic trailing-point lay-out.

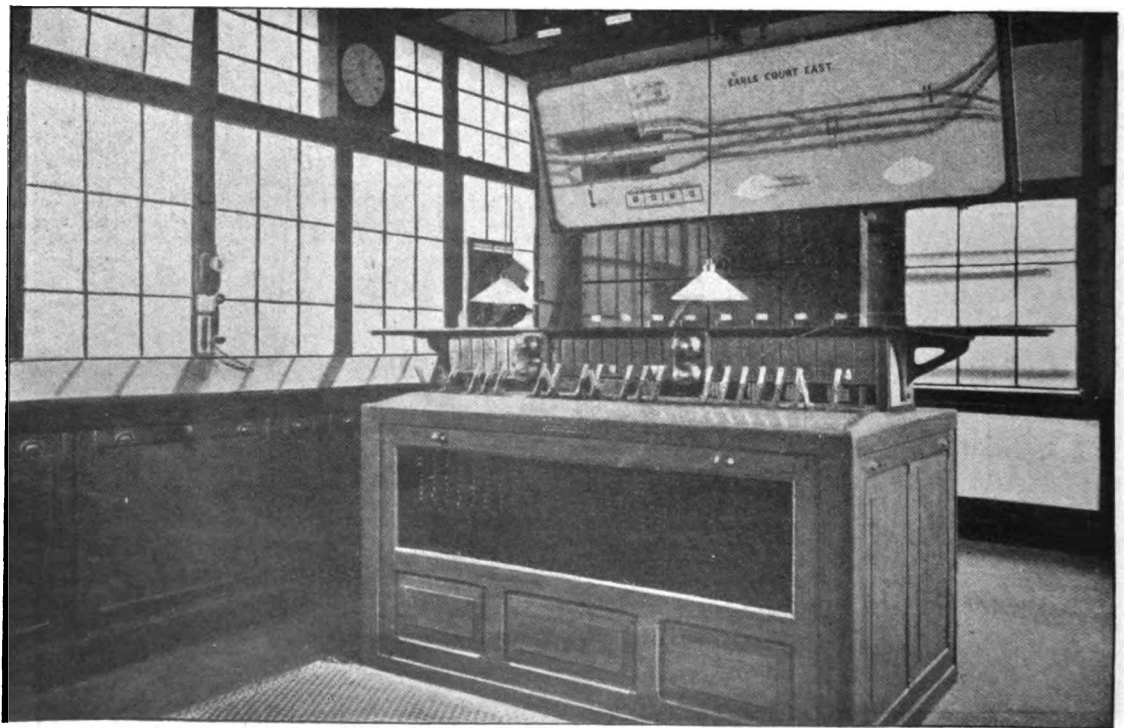


Fig. 7. — Earl's Court East signal cabin.

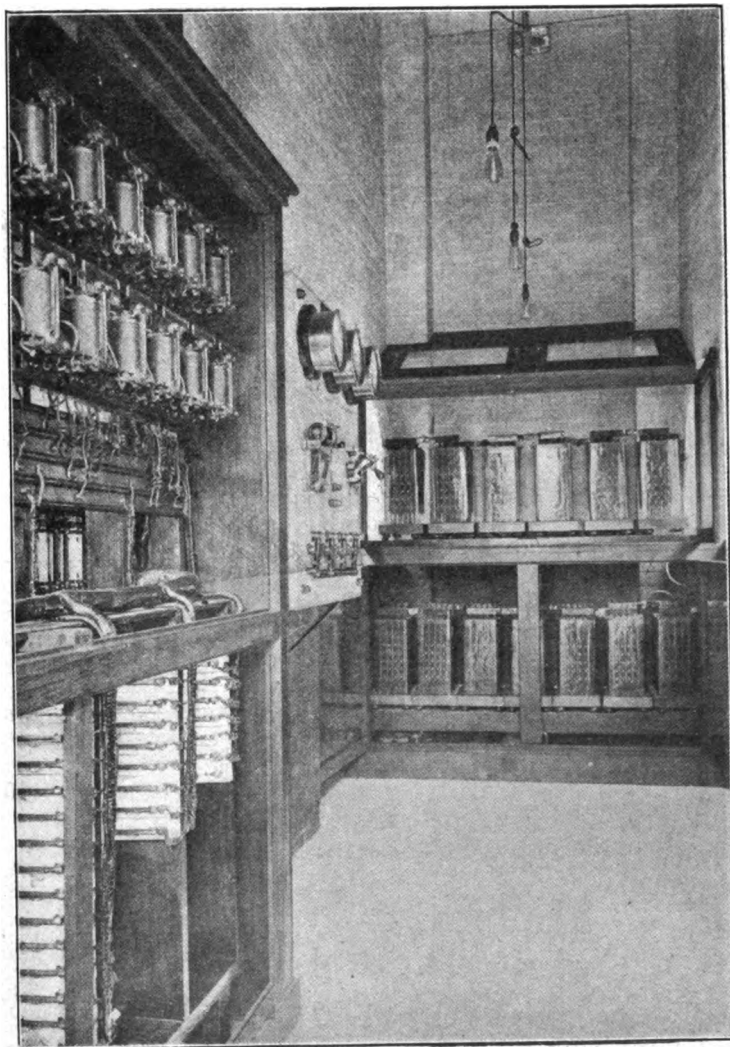


Fig. 8. — Wiring and relays at South Kensington.

A black and white photograph showing a close-up view of a railway track. The rails are visible, and there are mechanical components, possibly part of a signaling system or a switch, mounted on the track bed. The components include metal plates and rods, secured with bolts. The track bed is covered with gravel or ballast.

Digitized by Google

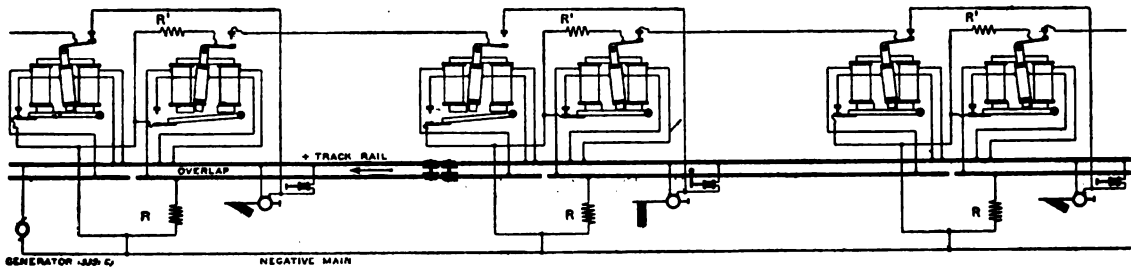


Fig. 10.

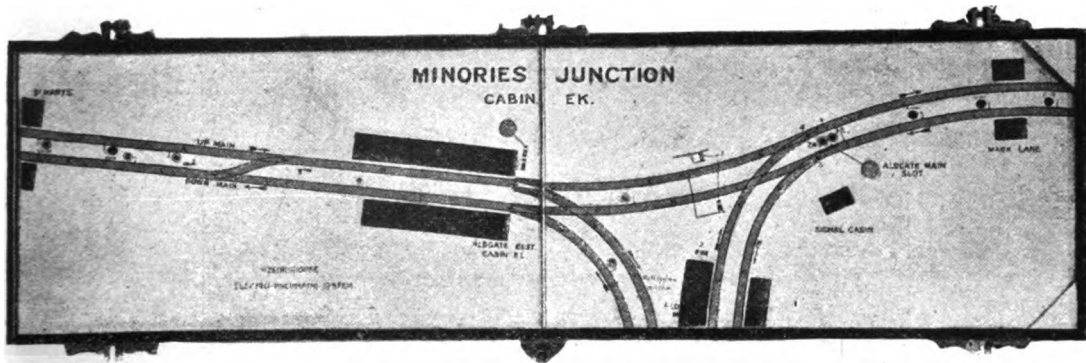


Fig. 12.

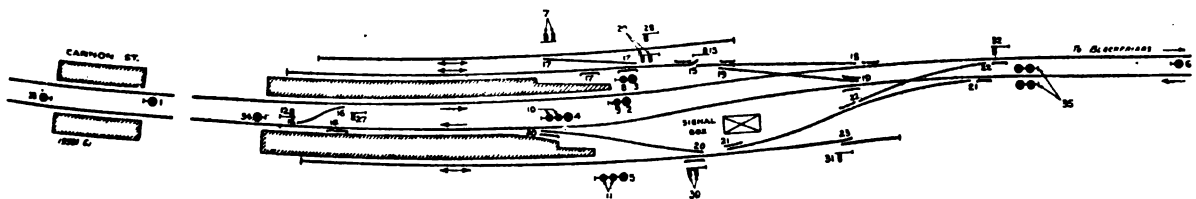


Fig. 13. — Signal diagram; Mansion House Station.

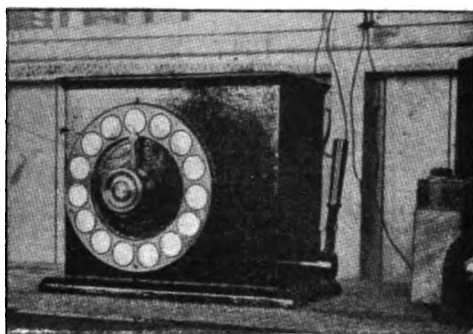


Fig. 14. — Transmitter.

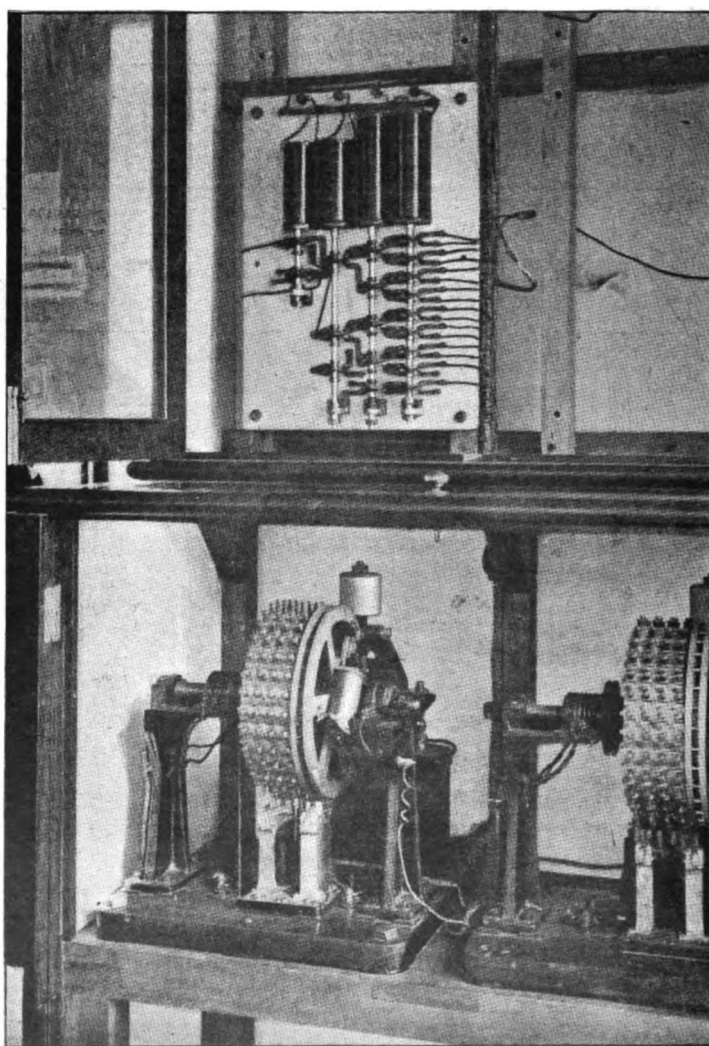


Fig. 15. — Combinator and receiver of train description apparatus.



Fig. 16. — Train-destination indicator.

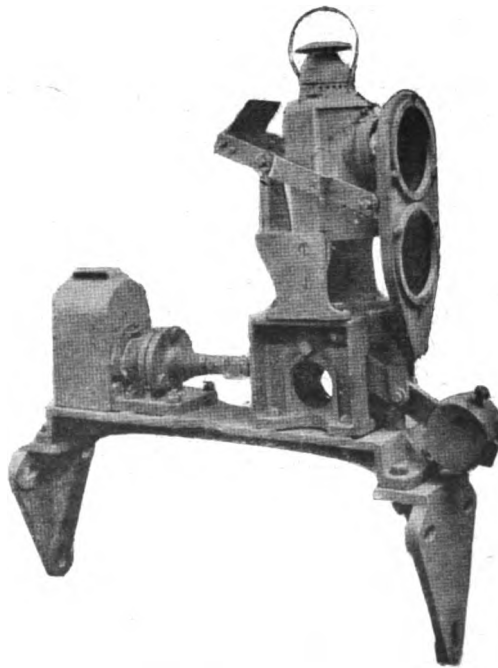


Fig. 18. — Signal on a tube railway.

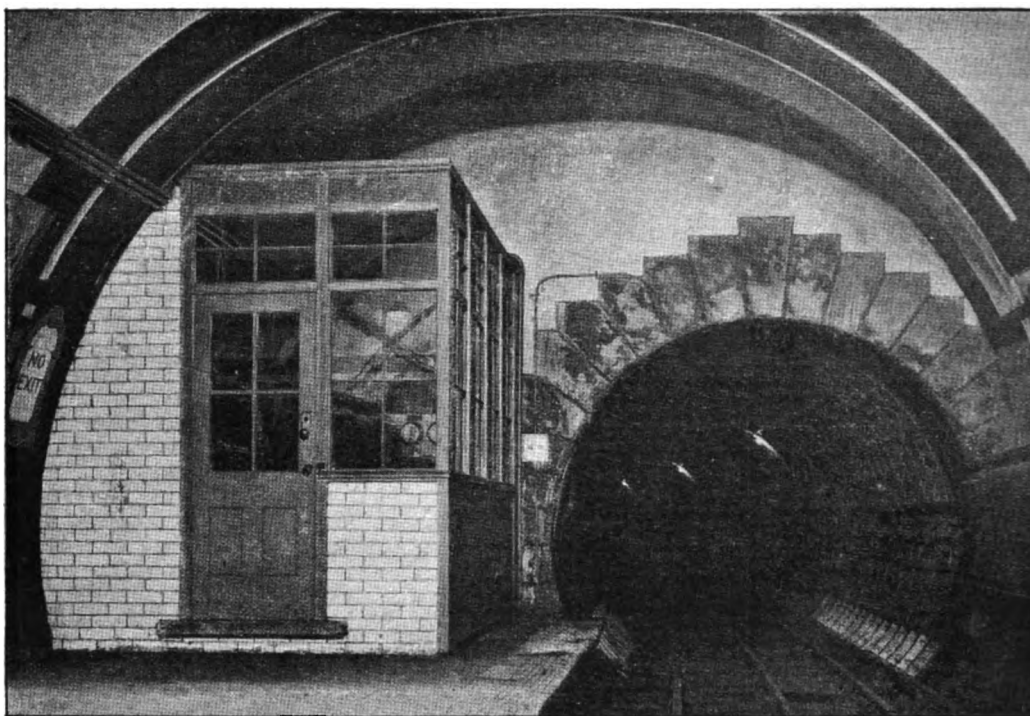


Fig. 17. — Kennington-road cabin; Baker-Street and Waterloo Railway.

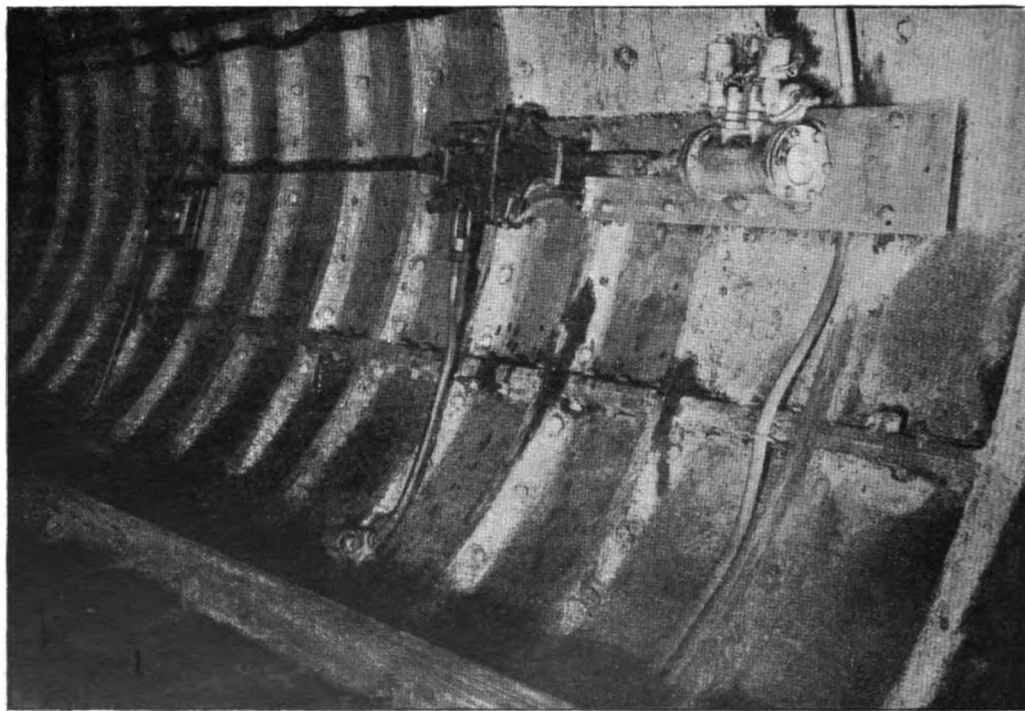


Fig. 19. — Facing-point motor and movement on tube railway.

The principles of the system may be best understood by reference to the diagram in Figure 10. One of the track-rails is electrically continuous through the whole length of the installation, and constitutes the positive conductor from the generator to the individual track sections. The other rail is cut up into block sections by means of special rail-joints insulated with fibre. All uninsulated rail-joints are bonded to ensure electrical continuity. The negative signal main is connected to each section of the sectionalised track-rail at a point near the latter end of the block — *i. e.*, the end at which the train leaves, as distinct from the end at which it enters. Resistances are inserted in the connections between the negative main and the sectional rail which reduce the potential difference between the rails to from 2 to 4 volts, according to the length of the block and the various local conditions.

Let us take the circuit for a single block unoccupied by a train. The positive current from the generator flows along the continuous rail, and thence through the two relays, one at each end of the block, and through the ballast between the rails, all in parallel, to the sectioned rail. From this it flows through the resistance to the negative main, and back to the generator.

Now suppose a train enters the block. Obviously, the current now flows through the practically negligible resistance of the car wheels and axles from one rail to the other, and the relays are shunted, with the result that the signal is allowed to go to "Danger."

The "track" resistances connected between the negative main and the sections of the sectionalised rail prevent the generator being short-circuited when the track-circuit is shunted by the axles of the train. In fact, these resistances bear such a relation to the combined resistance of the road-bed from rail to rail, and the two relays, all in parallel, that the shunting of the track cuts out only a small percentage of the total resistance of the circuit. Thus the current increase in a circuit, when shunted, is not great; this is important, as it is advisable to keep the track potential as nearly as possible constant. An increase of the total current, resulting from the blocks being occupied by trains, affects the potential between the rails of unoccupied sections by increasing the transmission loss in the negative main.

The loss in the continuous track rail may generally be neglected on account of its large section. Another circumstance directly affecting this track potential, is the variation of the resistance of roadbed according to weather conditions. Broken stone forms much the best ballast from an electrical point of view, and cinders the worst. It may here be mentioned, however, that though on several occasions the track-rails between Ealing and Harrow were flooded, the operation of the signals was in no wise interrupted.

Let us now consider the circuits of the track-relays which control the signal-circuits. Figure 10 is a diagram of the relay and signal-magnet circuits for two blocks. The track-coils of the relays are permanently connected across the rails at the ends of each block, the appearance of the connection to the track being shown in Figure 11. Between the pole-pieces an electro-magnet is suspended from a pivot. This magnet is wound to a high resistance, and is connected between the positive rail and the negative main through a contact — operated by the track-coil armature — which is closed when the track-coils are energised. To the swinging coils is rigidly connected an arm which actuates a contact, the function of which is to open or close the local circuit controlling the signal-motors. The operation of the relays is as follows: — When a difference of potential exists in the normal direction between the rails — *i. e.*, when there is no train on the block — the relay track-coils are excited, and draw up the armature which closes the circuit through the swinging coil. This swinging coil is then attracted to one of the poles of the relay, and, swinging over, closes the contact in the local signal circuit.

As already mentioned, there are two relays in each block, one at each end. These are duplicates, and operate normally in a precisely similar manner, each working a contact in the local signal-circuit. These contacts are in series, as shown clearly in the figure, and unless they are both closed no current can flow through the signal-magnet, and the signal will therefore remain at " Danger " by gravity.

The position of the apparatus when the block is empty has been indicated above — *viz.* : both relays energised, the local signal circuit closed, and the electro-magnetic valve operating the pneumatic signal, therefore admitting compressed air to its motor, thus holding the signal and train stop off. As soon as a train enters the block, the relays are short-circuited by the car-axes, and, being de-energised, their armatures drop, thus breaking the circuit through the swinging coil. The swinging coil then swings back from its position in contact with one of the track-magnet pole-pieces, and in doing so, breaks the signal circuit at two points. The electro-magnet operating the admission and exhaust-valves of the pneumatic signal motor is de-energised, and the exhaust is opened, so that the signal returns to " Danger " by gravity. It is a fundamental principle of automatic signalling that any external influence must, if it has any effect at all, cause the signal-arms to go to " Danger," and not bring them off.

So far, so good; but experience has shown that the great obstacle to the success of automatic signalling, on electric railways in particular, is the possibility of the relays being operated by extraneous current so as to cause a false " clear " indication when " danger " should be shown. The particular claim of the system under consideration is that it is impossible for an extraneous current in the running rails, from whatever source, to bring the signal arm to the " off " position when it should stand at " Danger."

The main source of extraneous currents affecting the signals is the traction-power circuit, and when, as on the railways whose signalling we are now describing, the track is not used as a return, the presence on the block sections of current from this source is abnormal. Faulty insulation of the train equipment, positive and negative rails, positive cables, etc., is the most frequent cause of leakage to the track-rails. Whether currents other than the signalling current on the track-rails are normal, as would be the case were the track-rails used as a power return, or abnormal, as in the present case, is immaterial; such currents would be equally disastrous to a susceptible system, but are impotent to affect the signal system we are considering. Faults in the main power circuit occur with sufficient frequency to demand the closest attention on account of the disorganisation of the traffic which they may cause: but whether frequent or rare, a system in which there was the least liability to give false signal indications of safety would at once forfeit all claims to consideration.

Although in the present system it is possible for extraneous currents to energise one or both relays while the train is in the block, they are so interconnected that it is not possible for them both to be energised in the normal direction at the same time by extraneous currents.

The various conditions which may occur with a train in the section may be catalogued as follow :

Both relays shunted, no extraneous current. (Normal.)

One relay shunted, the other energised normally. (Signal-circuit broken at one point.)

One relay shunted, the other energised reversely. (Signal-circuit broken at two points.)

Both relays energised, one normally and one reversely. (Signal-circuit broken at one point.)

The circuit through the signal magnet is designed to be always open at one point when a train is in the section, and often at two.

As will be seen from the diagram, the train-stop is electrically in parallel with the signal, and therefore is directly controlled by the signal-circuit passing through the relay contacts.

For supplying compressed air for operating the points and signals, an air main 2 inches in diameter runs from one end of the line to the other. This is fed by electrically-driven air-compressors (in duplicate) which are placed at each sub-station. Each compressor is provided with a governor, which automatically starts and stops it, so as to keep the pressure at 65 lb. to 70 lb. Owing to the cramped conditions of the lines and sidings at stations, and the necessity for rapid movements, operations have had to be provided for on the District Railway that are regarded with disfavour on ordinary lines; such, for instance, as the movement of trains on the facing road, as has to be done at Earl's Court. These operations are properly safeguarded by interlocking and controlling between the cabins interested, and to this the security of the track-circuit is added.

The rule adopted by steam railroad companies, that a guard must not give the driver a "Right-away" signal if the fixed signal is at "Danger", is in force on the District Railway. As the conductors of the electric trains cannot always see such signals, signal-indicators are placed on the platforms. These take the form of a signal-lamp, with two lenses facing forward and two lenses facing backward. The upper lenses are yellow and the lower green, and the lights therein are changed to correspond with the fixed signals. This introduction of yellow is interesting and desirable. Red was unsuitable, as it might be confused with a stop-signal; whilst the use of yellow may lead to its introduction on British railways for the "on" position of distant signals, and so remove the anomaly and inconsistency of the use of a red light that a driver is allowed to pass. The glass used is Kopp's patented signal yellow. All glasses under the Kopp patents are spectroscopically tested to see that the colours are practically pure. They may be obtained from the Westinghouse Brake Company, Limited.

Whilst there are many novel features to be found in the signalling of the District Railway, there are two decidedly absolutely novel ideas. One of these is an illuminated diagram, which shows the signalman what lines are occupied, when connections are fouled, and when trains are approaching (fig. 7 and fig. 12). The diagrams are similar to those ordinarily used in signal-cabins, but the roads, points, and signals are painted on glass, which is opaque all over, except the roads. Electric lamps are placed behind the roads in the diagram, and are partitioned off in lengths to correspond with the track-circuit block sections; they are so controlled by the track-circuit relays as to be always alight, except when the circuit is opened owing to the presence of a train in the section, when the lights go out, and so advise the signalman that the section is occupied. It is a marvellous thing to a railway man to see how signalmen — such as those in the Mansion House cabin — are able to do their work practically in the dark. They can see but few of the points and signals they operate, and yet are able to cope with the greater frequency of trains now called for, and to manipulate the signals and points with remarkable rapidity; and all this with an accuracy that is astonishing. This is done entirely by means of the illuminating diagram, which includes the block sections eastward to Monument Station, and westwards to Blackfriars; consequently no advice is required by the signalman as to the approach of trains, and no block instruments whatever are in use — another source of astonishment to railway men. A diagram showing the roads operated from the Mansion House cabin is given in figure 13. It will be seen that the signalman governs the movement of trains up to the signal protecting the east-bound train at Monument Station and the west-bound line at Blackfriars. This cabin was one of the last to be opened. This was done on Sunday, February 25, 1906; and although the work was delayed owing to some connections being damaged by a derailment the previous evening, the old connections were disconnected

— and almost entirely removed — and the new apparatus was brought into service within three hours, and there was not a single failure reported the following day.

The other decidedly novel feature is the magazine train-describer (Westinghouse patent). In ordinary steam railway practice, trains are described from one cabin to the next by means of bell codes or train-describers. Where, however, owing to the use of automatic signals, there is more than one block section between two adjacent cabins, these become impracticable, as there is no permanent record of their indications, and the signalman would have to trust entirely to his memory for setting the road and pulling off the right signals. On the District Railway, where there are in one case twenty-five block sections between two cabins, and the trains run so close behind one another, such a course is obviously impossible. The magazine train-describer has overcome this difficulty. To understand its workings, the action of the men at the Mansion House and South Kensington for trains going westward may be followed. On the shelf in the Mansion House cabin there is a transmitter (fig. 14), on the face of which there are fifteen circles, providing for fifteen different indications. On each of these circles the head-lights of the various trains are indicated. The signalman, when a train departs, turns the pointer to the circle corresponding to the "marker" on the train, and then pulls forward the handle on the right, whereby from one to four circuits are completed. Through the tunnels run four electric line wires, which are coupled to the transmitter at the Mansion House, and to a receiver at South Kensington (fig. 15). These make up a combination of a code composed of changes rung on the four letters A, B, C, D. In the transmitter there is a commutator, which groups the four wires of the cable in fifteen different ways, one for each of the positions of the pointer. The pulling of the handle connects the source of current to the cable by means of the commutator, and the required combination of electrical currents is thus sent to the other end. Here the cable is attached to four electro-magnets, each provided with a hammer. These magnets stand under the drum of the receiver (lower part of fig. 15), and act upon one of the row of four studs which occupy the periphery of the drum. Through the action of the hammer the studs are suitably pressed in, and after the magnets have been energised, the drum automatically turns one division, and so presents a fresh row of studs to be acted on by the hammers the next time the signalman at the distant end describes a train.

Inside the drum is a set of four springs, which wipe against the inner end of those studs which have been pushed in by the hammers. When the drum revolves after receiving a train description, it carries, these springs with it; but the springs themselves are capable of movement in the opposite direction to the drum as well, such motion being imparted to them, one step at a time, each time that the receiving signalman passes a train on to the next section.

These four springs pick up a current from each of the studs which have been pressed in by the hammer before mentioned, and by means of the combinator (consisting of four magnets, and shown in figure 15 above the receiver) these currents close one of the fifteen circuits corresponding to the description sent. Each of these circuits actuates a drop of an annunciator, similar to an hotel-bell annunciator, placed on a shelf over the locking-frame. As long, therefore, as the springs rest on studs which have been pushed in, the corresponding head-light appears in the annunciator. Only one indication is shown at a time, and that is a description of the next train approaching. The man at the Mansion House sends, as each train leaves, a description of the train which, as already indicated, is registered on the magazine; but as only one train can be shown on the annunciator at one time, the remaining indications are stored up. After a train has arrived at South Kensington, the signalman cancels the indication by means of a plunger on his shelf. This plunger moves the springs forward, and the description of the

previous train disappears and the next train appears in the annunciator. The springs, in passing from one set of studs to the next, automatically release the previous studs, so that these are ready to be operated on by the hammers in due course. The drums are entirely self-winding, and therefore the studs may be utilised over and over again without attention.

Associated with this arrangement is the train-destination indicator on the platforms, as illustrated in figure 16. Hereon are marked the possible destinations of trains, and on the painted glass at the side are figures 1, 2, 3, which are, however, ordinarily invisible. Behind these numbers incandescent lamps are placed, and these light up and show 1, 2, 3 on different parts of the board, to correspond with the order of approaching trains. The sequence of trains, as shown in figure 16, is : First, an Inner Circle, then an Addison-road, and finally a Richmond train, and passengers are thus kept fully informed as to the destination of the next three trains. These train-destination indicators are worked by a magazine train-describer fitted with three sets of springs, instead of one, as described above, placed in the circuit running between the adjacent cabins, so that the same sequence of trains is stored up here as in the cabin. As the train leaves the station, it automatically causes the 1 to disappear and changes the 2 and 3 into 1 and 2 respectively, and causes a new 3 to appear. These train-destination indicators are being fitted at all the tunnel stations on the District Railway, and at some of the other important stations. At converging junctions, similar to Earl's Court and Mill Hill Park, the signalman is at liberty to take on one train before the other; and here, instead of numbers appearing opposite the name, a lighted horizontal shaft is shown. On accepting one or the other, the signalman plunges, and an arrow-head appears on the shaft showing that train which is coming in first. At Earl's Court, where there are lines for trains in the same direction on both sides of the platform, the arrows point towards that line on which the train will run in.

It may here be mentioned that, in order to prevent the signalman getting "out of step" when cancelling his receiver, his plunger is so controlled that it is locked as soon as there are no more trains on the drum. This locking serves the purpose of informing the signalman when the last train at night has passed.

Each block section is numbered. The signal and track circuit bear the same number, prefixed by S and T respectively. Signal-cabins are designated by letters.

There are — or will be when the work is completed — 410 track circuits and 488 signals. The number of signal and point movements per day are about 40,000, with a maximum service of thirty trains per hour.

### **Baker-Street and Waterloo Railway.**

This line is signalled in a similar way to the Metropolitan District Railway, but naturally the apparatus had to be designed somewhat differently from that on the latter line, in order to suit the altered conditions of a tube. The whole line, when completed, will extend from Paddington to the "Elephant and Castle", but in the portion of the line now open — Baker-street to Kennington-road — there are but three cabins (all electro-pneumatic) — *viz.*, Melcombe-place (west of Baker-street), where trains cross over from one tube to the other; Kennington-road, which now temporarily forms the southern terminus; and London-road. Melcombe-place cabin is completely in the tube, and is approached by a signal-ladder and trap-door in the floor. London-road is at the dépôt on the surface, near St. George's-circus. Here again a position has been chosen for the cabin that is very difficult from a mechanically-signalled point of view.

Kennington-road cabin (fig. 17) presents a unique feature. Owing to the line temporarily

terminating at this station, and there being no cross-over beyond, but one line and one platform is used, and this line and platform are situated in the tube other than the one in which the signal-cabin is placed. Therefore the whole of the traffic — a three-minute service — and the working of the crossover road for each northbound train, is operated by the signalman without seeing a single train, signal, or points. As on the District Railway, there are no block instruments, so that the signalman is entirely dependent on the illuminated diagram. He appears to suffer no inconvenience whatever from this isolation : a splendid testimonial to the use of track-circuits and an illuminated diagram.

As the tube is small — 11 ft. 6 in. being the standard diameter — the signals had to be made especially small. One is shown in figure 18. In front of the lamp there is the usual spectacle, the motor itself being placed behind this, instead of under it, as in the larger tunnel signal. This signal projects but 10 inches from the side of the tube. The signals, as well as the point motors and movements, are fastened to the wall of the tube in order to keep the 4-foot way as clear of obstructions as possible. The position and method of attachment of the mechanism for working a set of points is illustrated in figure 19.

#### **Great Northern, Piccadilly, and Brompton Railway.**

This line is also being fitted with similar apparatus. There will be about five cabins.

The signalling on the District Railway was opened gradually, and is, in fact, not yet complete (May, 1906). No reliable figures, therefore, as to the ratio of signal failures to the total number of signal movements can be compiled; but, as showing how successful the Westinghouse automatic signalling has proved, it may be mentioned that during the ten weeks that have elapsed since the opening of the Baker-Street and Waterloo Railway, the number of signal failures has averaged but 1 in 75,500 movements. During the last fortnight of that time the average was but 1 in 98,600 movements. In no case did the failure result in the signal being at "Clear" when it should have been at "Danger". When we recollect all the difficulties of the situation — an entirely new system, and the men quite new to the work — it may be said that this record points to a high state of perfection.

The whole of the signalling apparatus here described was installed by the Underground Electric Railways Company, Limited, of which company Mr. J. R. Chapman is the general manager and chief engineer; and was designed and supplied by the Westinghouse Brake Company, Limited, who manufactured the greater part of it at their works at 82, York-road, King's Cross, London, N.

## THE PENNSYLVANIA RAILROAD'S EXTENSION TO NEW YORK AND LONG ISLAND.

---

Figs. 1 to 5, pp. 1528 to 1532.

---

(*Railroad Gazette.*)

---

The new Pennsylvania Railroad station in New York, for which the plans are now practically perfected, will be unique among all the railroad stations of the world in the number and convenience of its entrances and exits. This condition is due to the fact that each of the four sides of the structure is a front, opening respectively on two wide avenues and two important streets, which latter have been widened by the company to 80 feet each.

The geography of the station is interesting. It is bounded on the east by Seventh and the west by Eighth avenue; on the south by Thirty-first and the north by Thirty-third street, Thirty-second street having been closed and included in the station site. In the center of the hotel, theatre and shopping district, the advantage of its position is obvious. The frontage on the avenues is 430 feet and on the streets 780 feet, the sides of the structure forming a perfect parallelogram. As the tracks are 40 feet below the surface of the streets, the station is divided into three levels. From the street level upwards, the walls of the structure rise to the height of 60 feet except in the center, where the roof of the general waiting room reaches a height of 150 feet, and the corner of Eighth avenue and Thirty-third street, where there is an elevation of four stories for office purposes. The architectural design of the entire exterior is a Doric colonnade, 35 feet high, surmounted by a low attic, raising the general elevation to 60 feet. The unusual extent of the building in area and its general type are suggestive of the great baths of ancient Rome. In fact, the baths of Caracalla, still magnificent in their ruins, were the inspiration of this architectural plan.

Although the building is low by contrast with its skyscraping neighbours, its scope makes it impressive, and the lofty roof of the waiting room, rising high above the top of the surrounding structure, with its eight large semi-circular openings, 72 feet in diameter, adds dignity to the group of buildings and at the same time makes them a conspicuous landmark, when seen in perspective from the streets. In appearance it is a wide departure from the conventional railroad station. One misses the turrets and towers, and more than all, the lofty arched train shed, but as the principal function of this station is performed underneath the streets, the upward and visible signs of the ordinary railroad station are naturally absent. It will rather resemble some vast auditorium constructed on low lines for the easy ingress and egress of a multitude of people.

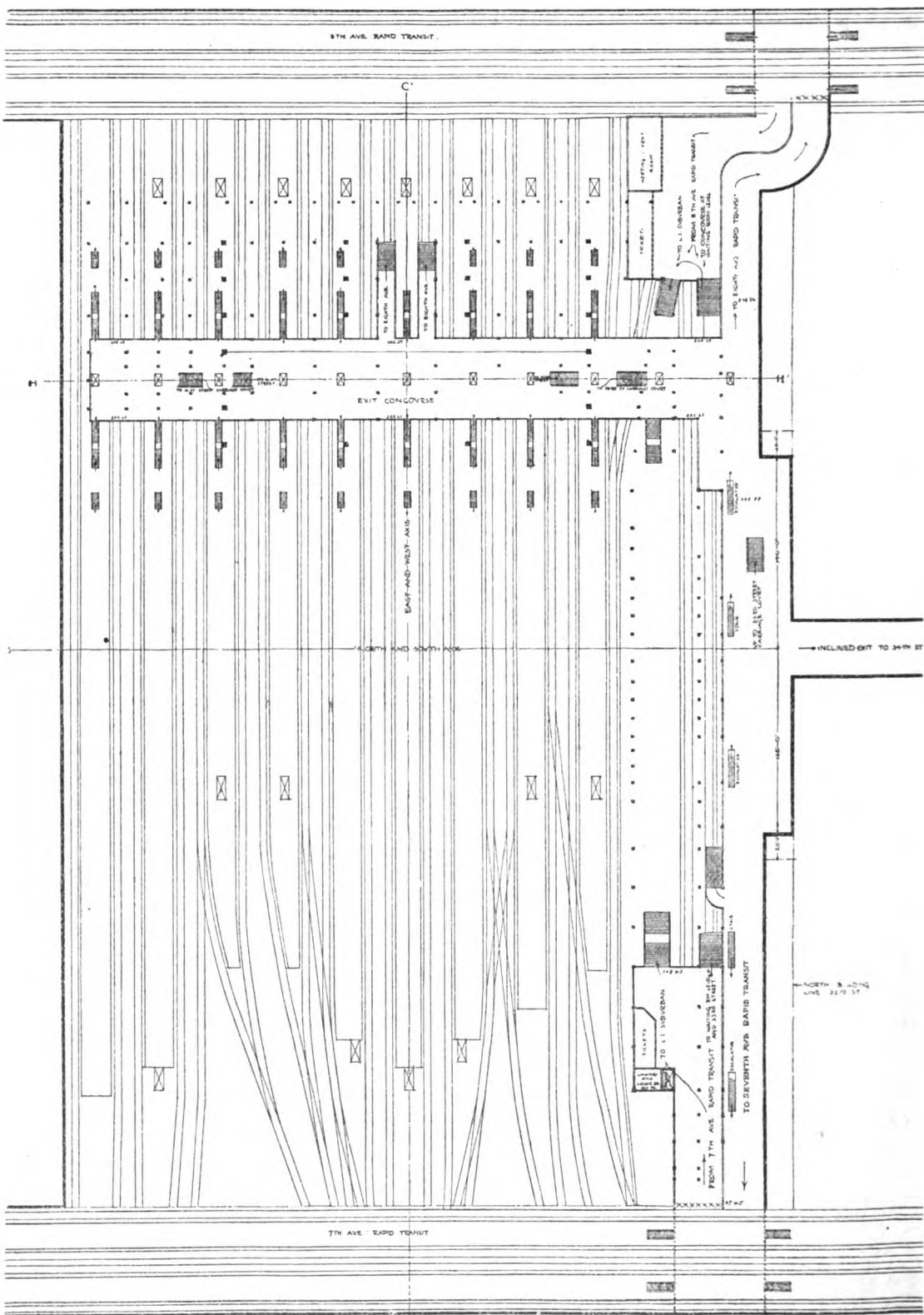


Fig. 1. — Track plan, Pennsylvania Station.

The exterior construction is to be of pink Milford granite, similar to the building stone of the Boston Public Library, the University Club in New York, the Court House in Pittsburg, and the Chamber of Commerce in Cincinnati.

The main entrance is in the center of the structure on Seventh avenue, opposite the intercepted end of Thirty-second street. This is for foot passengers only, and from the street entrance to the stairway to the main waiting room, there extends an arcade 225 feet long and 45 feet wide flanked by shops, which will be occupied by merchants, whose wares will appeal especially to the requirements of travellers. On either side of the Seventh avenue entrance, there are also a series of stores. At the further end of the arcade the restaurant, luncheon rooms and the café are established, with proper kitchens and service connections. Beyond, is the general waiting room and the concourse, all easy of access by convenient stairways.

At the corners of Thirty-first and Thirty-third streets and Seventh avenue are open pavilions, which furnish carriage entrances for incoming and outgoing traffic. Under cover, carriages descend from the street level by a slight gradient about 20 feet to the level of the station proper, the Thirty-first street incline being assigned as an entrance and the Thirty-third street ascent as an exit. By this arrangement, carriage passengers are delivered at the most convenient entrance to the general waiting room.

Apart from the main entrance, there are other convenient entrances for foot passengers from the street level to the general waiting room and concourse from both the streets and the avenues. At a central point in both streets wide bridges leading into the street floor of the station span the carriage subway. On the intermediate plane or level, the real business of the passenger preparatory to his journey is transacted.

The general waiting room, the largest of its kind in the world, 320 feet long, 110 feet wide and 150 feet high, is the central section of the plan. Within its spacious walls will be located the ticket offices, parcel rooms, telegraph and telephone offices and baggage checking windows, all so disposed as to situation that a passenger may proceed from one to the other seriatim, with a minimum amount of exertion and without retracing his steps.

Adjoining the general waiting room on the west, are two subsidiary waiting rooms, 58 by 100 feet, for men and women respectively, provided with seats, and opening into retiring rooms, with lavatories attached.

To the east of the general waiting room the main baggage room, with 450 feet of frontage, for the use of the transfer wagons, is located, covering the full area occupied by the arcade and restaurants on the plane above. The baggage is delivered and taken away through a special subway, 30 feet wide, extending under and along the entire length of Thirty-first street and Seventh and Eighth avenues. From the baggage room, trunks are delivered to the tracks below by motor trucks and elevators.

The cabstands will also occupy this level. There will be maintained an ample service of electric vehicles of varying capacities to meet the requirements of travellers.

Parallel to and connecting with the main waiting room by a wide thoroughfare and west of the subsidiary waiting rooms is the concourse, a covered assembling place over 100 feet wide, extending the entire width of the station and under the adjoining streets. An idea of the width of this concourse is gained by a comparison of it with the lobby of the Jersey City train shed, which is narrower by 25 feet. This may be termed the vestibule to the tracks, as two sets of stairs descend from it to each of the train platforms on the track level. The concourse and adjacent areas are open to the tracks, forming a courtyard 340 feet wide by 210 feet broad, roofed by a lofty train shed of iron and glass, similar in design to the famous train sheds of the

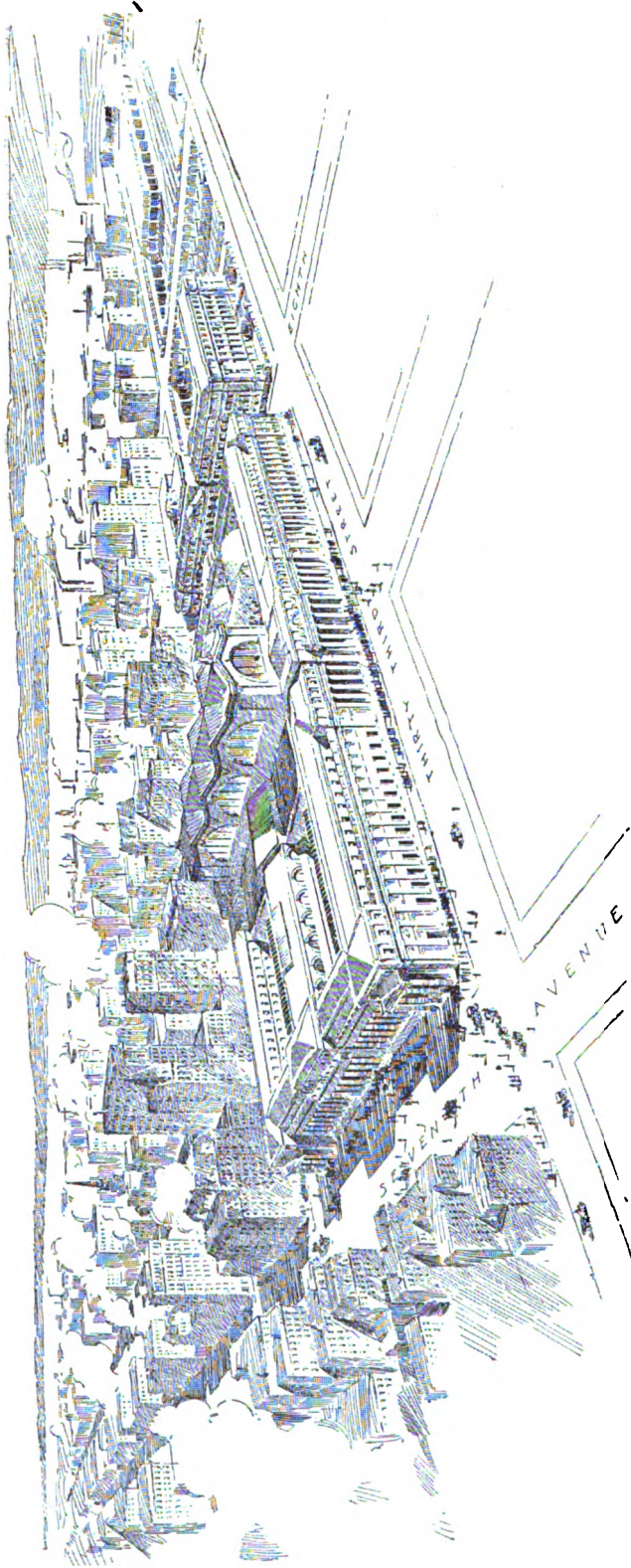


Fig. 2. — Bird's eye view showing location of Pennsylvania New York Terminal.

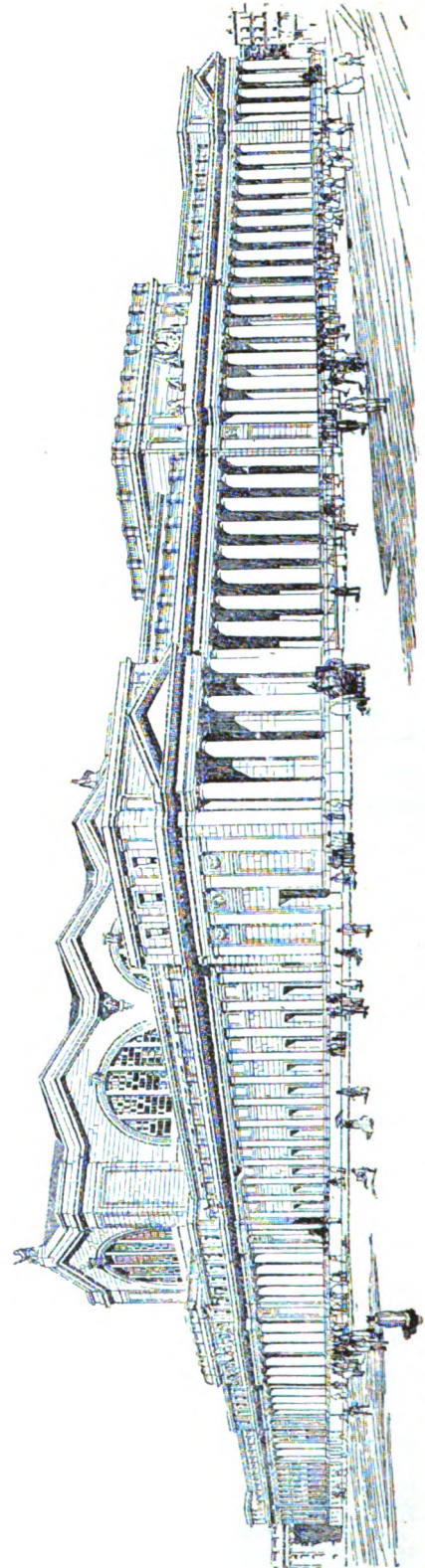


Fig. 3. — General elevation of station.

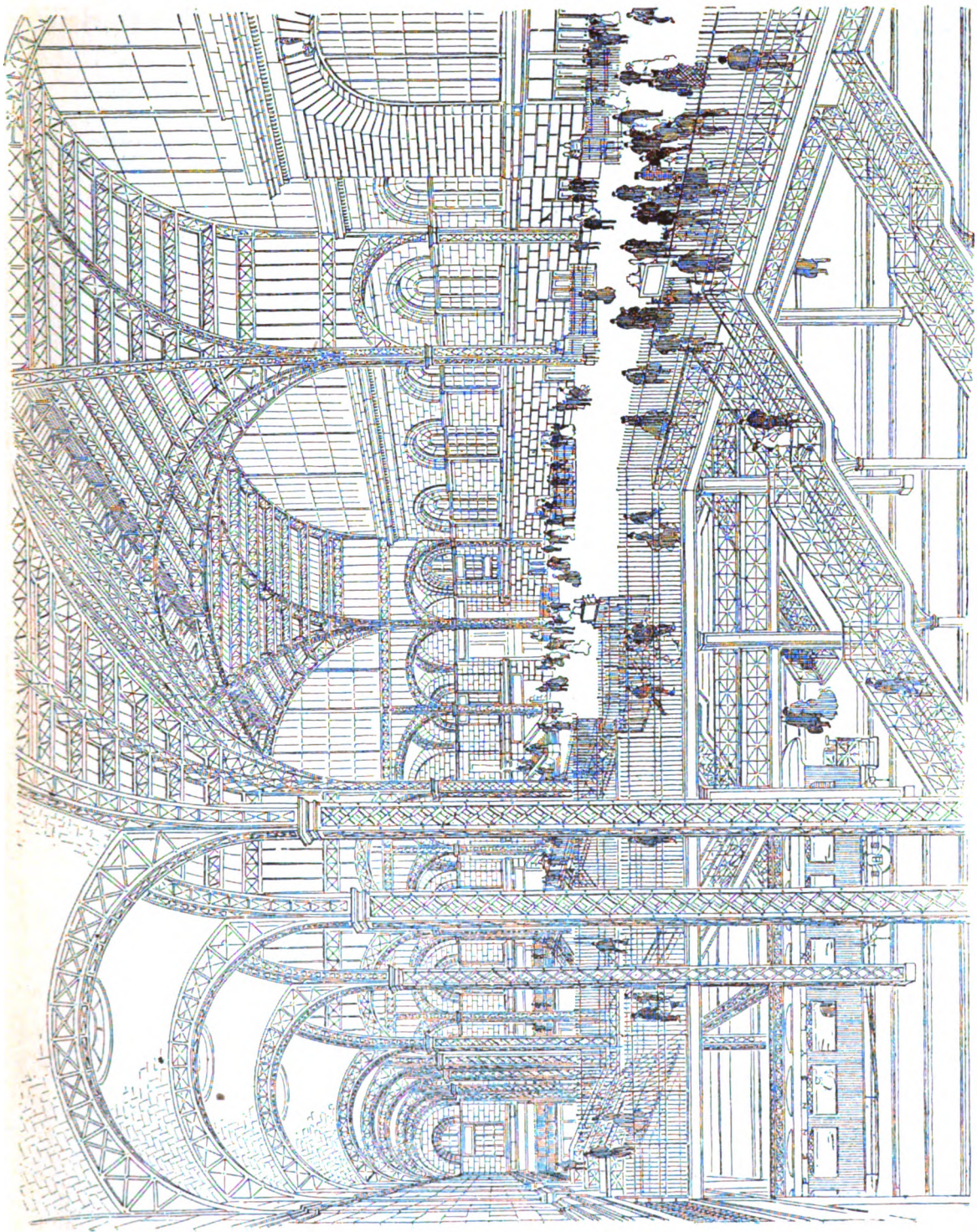


Fig. 4. — Concourse and tracks, Pennsylvania station.

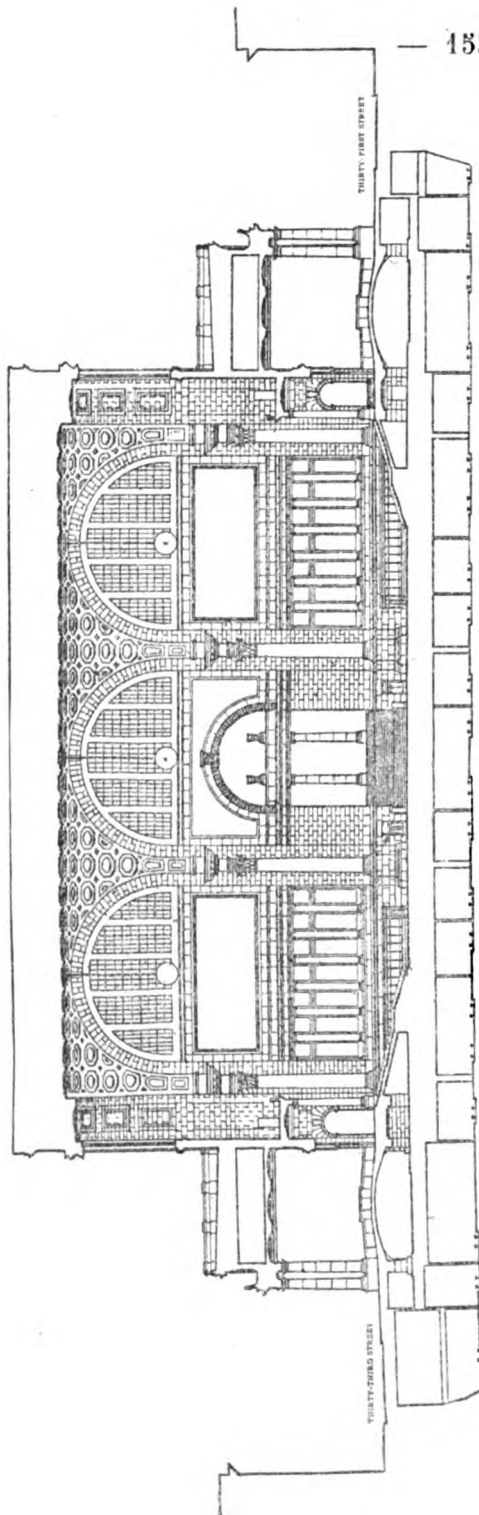


Fig. 5. — Section of station on north and south axis.

new stations in Frankfort and Dresden, Germany. In addition to the entrances to the concourse from the waiting room, there are also direct approaches from Thirty-first, Thirty-third streets and Eighth avenue.

The gates of the stairs descending from the concourse to the trains will bear signs announcing the name, destination and the time of departure of the train on the particular platform where the stairs land.

Auxiliary to the main concourse and located between it and the tracks, is a sub-concourse, 60 feet wide, which will be used for exit purposes only. This passage-way is 18 feet above the tracks, but is connected with the track level by two stairways and one elevator from each platform. From it ample staircases and inclines lead directly to Thirty-first, Thirty-third and Thirty-fourth streets, to Eighth avenue and to future rapid transit stations under Seventh or Eighth avenues. Direct connection may also be made with the proposed subway stations on Herald Square without ascending to the street level.

The northern side of the station extending along Thirty-third street will be assigned to the suburban service of the Long Island Railroad, into which trains will run from all points on Long Island by way of the East River tunnels. Ample entrances and exits are provided on Seventh and Eighth avenues and Thirty-third street, so that this traffic can be handled in connection with the adjacent subways and the surface lines on the surrounding streets independently of the rest of the station.

The third level, which is at a depth below the surface of the street corresponding to the height of a four-story building, is the track level. When the two tracks emerge from the tubes under the Hudson and reach the entrance to the station yards at Tenth avenue, they begin to multiply, and at Ninth avenue, and extending into

the station, the total number has grown to 21. There is also a reduction in the number of tracks leading out of the station to the east, to a total of four for the main line, two passing under Thirty-second and two under Thirty-third street, and thence under the East River to the Long Island City yards. The track surface of the station may be compared to two unfolded fans joined together at the open ends, the handle of one extending under the Hudson and that of the other under East River. Within the station area, covering 25 acres of ground space, there are 16 miles of tracks. This trackage area will afford ample facilities for easy movement of many hundred trains per day by the prompt and efficient means of electric power. Through train from the western side of the Hudson, after discharging passengers, will proceed at once to Long Island City, where the train yards and terminals will be located, thus leaving the station tracks clear of any idle equipment, and likewise the westbound through trains made up at the Long Island City terminal will pass through the station, stopping only to take up their quota of passengers. The suburban service of the Long Island Railroad will be operated on the "shuttle" plan, by which the trains are kept in continuous motion in and out of the station.

The planning of the station, with its numerous entrances and exits independent of each other and separating the incoming from the outgoing throng, was worked out to facilitate, in the greatest measure, the prompt and uninterrupted movement of the traffic.

The exposure of the building on all four of its sides to main arteries of street traffic gives the plan a flexibility, which is rarely obtainable in a building of such enormous proportions situated in the heart of a great city, and also insures easy connections by underground subways with the future extensions of the city's rapid transit system under Seventh and Eighth avenues and the cross streets.

The designs for the station were made by McKim, Meade and White, and will be executed under their direction.

---

SECOND CONFERENCE FOR THE REVISION  
OF THE  
INTERNATIONAL CONVENTION ON THE TRANSPORT OF GOODS BY RAILWAY.

---

(*Bulletin des transports internationaux par chemins de fer.*)

---

As Mr. Zemp, federal councillor, remarked in his inaugural address, that the second conference of revision should, according to article 59 of the international convention, have been summoned for 1899, that is, three years after the 1896 conference. The preparations necessary should have been made in 1898, at the latest. But as it was already foreseen in 1898, that the ratification of the decisions of Paris by all the States, and consequently their coming into force, would require considerably more time, the Federal Council, at the request of the Central Office, proposed, on August 30, 1898, to the States concerned, to postpone the conference, and all the States without exception accepted this proposition. When subsequently, on October 10, 1901, the decisions of the Paris conference came into force, it then became necessary, during the second half of 1902, that the States concerned should send in their amendments which were to be submitted to the next conference. The request to this effect was actually issued on December 13, 1902, the States being requested to send in such amendments to the Central Office by the end of September, 1903. It was at that time intended to hold the second conference of revision towards the end of summer 1904. As however the proposals of several States had not yet been received in the middle of 1904 and were only submitted by the end of the year, a second postponement became necessary. The notices were therefore sent out at a later date; they appointed July 4, 1905, for the meeting of the States, at Berne, and on that day the conference accordingly met.

In this connection, it may be stated that as a result of past experience the Bern conference proposed that *the meeting of the delegates of the States concerned shall only be held at least five years after the modifications decided on at the last conference of revision have come into force.* The convention has been so satisfactory and its decisions have been recognized as so just, that these have been incorporated in the home legislation of most of the States concerned. Thus each amendment passed by the conference reacts on the home legislation of those States. It is hence neither necessary nor advisable that alterations should be made too frequently, and therefore an interval of five years is better than one of three.

These considerations duly affected the deliberations of the conference generally. The amendments proposed in no way affect the principles of the convention, and the rejection of a certain number of proposals is due to the wish of the majority not to disturb existing arrangements. It is for the same reason that the conference decided only to consider proposals in connexion with the list of subjects to be considered, and which consequently had been brought, before the meeting of the conference, to the notice of the States concerned, so that the delegates could receive instructions about them. For this reason, several proposals made during the meeting, and well worth attention, were not discussed; for instance, the proposal that the railway should be allowed to

deliver goods to the consignee who has withdrawn his refusal of delivery, before the said railway has received the instructions the consignor has been asked to give. The proposers were given the option of bringing forward these proposals at the next conference of revision.

\* \* \*

Among the proposals which were rejected at the Paris conference by a majority of votes, there were more especially two which were again brought forward, but not quite in the same form; these were again rejected.

The first concerned the *responsibility of the railway in selecting the route when the consignor has given no instructions on this point*. Austria and Hungary again proposed, maintaining their thesis with much energy, that the railway was responsible for the consequences of its selection by the same right as an ordinary carrier, or that — eventually — it was liable not only for a serious fault but for its fault generally. The supporters of this proposal urged the complaints made by many interested parties who insistently demanded an increase in the responsibility of railways. According to them, the responsibility for a serious fault is quite insufficient; the railways themselves recognize this in the arrangement of their tariffs, which admit the claims of consignors even in cases where there is no serious fault; it is equally erroneous to consider it a fault of the consignor not to indicate the route, for he has the *right*, but is not bound, to indicate it. On the other hand, the objection was raised that the proposals made by Austria and Hungary went too far, that the need for increased responsibility was not claimed in all the States, and that moreover the meaning of the phrase “by the same right as an ordinary carrier” was ambiguous, and that the meaning itself of “fault” was not the same in all countries. There was also a counter-proposal before the preparatory commission to omit altogether in clause 1 of article 6 the second sentence of paragraph 2, according to which the responsibility of a railway is limited to a serious fault; the result would be that the extent of the responsibility for selection of route would be determined in each State by its home legislation. This counter-proposal was passed by the commission with the consent of the Austrian and Hungarian delegates, by 6 votes against 5; but it was rejected at the general meeting, after very thorough discussion, by a similar number of votes (5 in favour of, 6 against), and this vote resulted in the rejection of the original proposal concerning the responsibility for selection of route.

Austria and Hungary also again brought forward the proposal, concerning article 10, submitted to the Paris conference, to allow the consignor to reserve for himself, by means of an entry in the way-bill, the right to carry out himself or by a representative the customs formalities on the way. This question was, both at the preparatory commission and the general meeting, a subject of as thorough a discussion as that of the responsibility of the railway in selecting the route. The representatives of Austria and Hungary met the objection, that the need for change had not made itself felt, by referring to the numerous petitions, requests and opinions continually emanating from the local business world, strongly expressing the desire to abolish what was called the monopoly of the railway in matters of customs clearance. Otherwise the arguments for and against were similar to those at Paris. More particularly was it stated that the proposed modification of article 10 would involve delays in the carriage and an increase in the responsibility of railways. These objections had been already raised before the commission. “The majority of the commission, taking into consideration that the proposal would be contrary to the legal principle that he who has the custody of an article is responsible for it; taking into consideration that in the majority of countries no real want in this direction has manifested itself;... finally taking

into consideration that under certain conditions the responsibility of railways would be increased, by the admission of strangers, and that the necessity, in all cases, of advising the representatives in question would cause a delay in the carriage, is of opinion that the proposal should be dropped." (Extract from the report of the commission.) The general meeting came to a similar decision.

The addition proposed to article 10 (4), of giving the right to be present during the administrative operations to the party concerned or to his agent, was also rejected. The same fate met proposals that the parties concerned should have the right of paying the customs duties and taking the customs receipts, which also tended to compel the railway eventually to carry out the formalities in the way most advantageous to the consignor.

On the other hand, the decisions of the Paris conference were amended in the following manner:

1° Paragraph 2 of the regulations originally laid down that paper of a dark pink colour should be used for quick freight way-bills. This was modified at the supplementary convention of 1898 (in accordance with the decisions of the Paris conference); the print on the quick freight way-bills (as on the slow freight way-bills) was to be on white paper, with a red band at the top and bottom edges, on both front and back of the paper. This has now been made more definite: the red bands on quick freight way-bills must be at least 1 centimetre ( $\frac{3}{8}$  inch) wide. In order however to allow existing stocks to be used up, this regulation will not come into force till not more than a year has expired after the coming into force of the modified convention,

2° At the Paris conference, a paragraph 5 had been added to article 7, in which it was specified (clause c), that "in case of overweight produced, during the carriage, by atmospheric influences, no excess rate is chargeable if the consignor proves that when loading the wagon he observed the regulations in force at the sending station". At it seems equally equitable to exempt the consignor from any penalty *when there is an increase of weight produced by atmospheric influences, which does not involve an excess rate*, it was decided to add to paragraph 5 of article 7 a clause d to this effect.

3° The right of control of the consignor, over the goods (article 15) has been definitely (in accordance however with the resolution on ultimate control passed at the Paris conference), so that it also includes *the right of ordering goods, which are being conveyed, to be returned to the sending station*; an addition to this effect was made to paragraph 7 of article 15.

Moreover the following alterations and additions were decided on:

#### a) International Convention.

1° *As regards the consigning and loading of goods*, the rules and regulations of the sending railway must of course be respected; just as the delivery of the goods is subject to the laws of the country in which the receiving railway is, as laid down in article 19. Article 5 was accordingly amended by a paragraph 5 as follows:

*The consigning and loading of goods is to be regulated according to the laws and regulations in force on the lines of the administration to which the sending station belongs.*

2° *Contents of the way-bill* (art. 6). — a) According to the actual wording of clause c of article 6, the way-bill must contain "the name of the receiving station, the name and address of the consignee". It was decided to add to this clause c the words "*and, the case arising, the statement that the goods are addressed to an office or station, to be called for*". The need, for

business purposes, of being able to send goods "to be called for" has been disputed by nobody, and it has been recognized that it should be possible to enter the instruction "to be called for" on the way-bill. On the other hand, a similar proposal, but of wider scope, was rejected; it was to the effect that if the consignor named himself as consignee, the instruction might be given that the railway should be authorized to deliver the goods to the bearer of the duplicate of the way-bill, on the production of the latter. The preparatory commission gave as reason for rejection that this alteration was far from meeting a general want, and that the consignor is at presentable to send the goods, before they are sold, by addressing them to himself, to be called for. Moreover, if the duplicate of the way-bill were accepted as an authorization for the delivery of goods, that duplicate would be given a value which the convention at present does not recognize it possesses, and in the nature of things it would become, among business people, a species of bill of lading, without the safeguards which the legislation of every country provides for the transfer of documents to order. In spite of the earnestness with which this proposal was urged by the delegates of the States who had submitted it, the conference did not adopt this innovation.

b) An addition was made to clause *h*, paragraph 1, article 6, to the effect that the way-bill must always contain *the reservation resulting from paragraph 4 of article 10*. In the original wording of clause *l*, the stations which had to be mentioned also included those where *the administrative examinations necessary had to be made*, and sub-division 1° of the first paragraph of the same clause *l* contains, as a new condition to which the power of the railway to select another route than that named by the consignor is subordinated, that *the station named by the latter for administrative examination is not to be changed*. — It was entered in the minutes that in so far as the administrative examinations enumerated under clauses *h* and *l* of article 6 and the necessary formalities mentioned in paragraphs 1 and 3 of article 10 are concerned, these proceedings also include the examinations and formalities of the sanitary authorities.

3° *Limitation of proceedings for the payment or recovery of overcharges*. — Very different legal opinions have arisen on the subject of the limitation of proceedings for the payment of overcharges, and more especially on the question of within what time overcharges are barred has had very diverse interpretations. In order to settle the doubts which have arisen in this connection, a new paragraph 6, article 7, was adopted, as follows :

*Proceedings for the payment or recovery of overcharges (chapter 3, paragraphs 1 to 5, and chapter 9, paragraph 2, of the regulations) are barred by limitation after a year, unless, as between the parties concerned, there has been an acknowledgment of the debt, a compromise or a judgment. The limitation dates, in the case of proceedings for the payment of overcharges, from the day the cost of carriage is paid, or if there has been no cost of carriage to pay, from the day the goods were handed over for carriage; in the case of proceedings for the recovery of overcharges, from the day when the overcharges were paid. The provisions of article 45, paragraphs 3 and 4, apply to the limitation mentioned above. The provisions of article 44, paragraph 1, do not apply in this case.*

4° *Carrying out the customs and octroi formalities of the goods at the receiving station*. — According to paragraph 5 of article 10, the consignee has the right to attend to the customs formalities at the receiving station, after the goods have arrived. The question whether, if this is not specified and if the consignee does not wish to exercise this right, the railway is bound to attend to the customs and octroi formalities, has been asked on sundry occasions and answered in different ways. The majority of the commission on considering the question, decided in the

affirmative and stated that it could hardly be doubted that when the international convention was founded, it was certainly intended that the railway should be so bound. The commission did not share the view according to which the eventual obligation of the railway is settled by the provisions of article 19, that is to say, by the laws and regulations in force at the destination. The conference adopted the conclusions of the commission and added to paragraph 5 of article 10 the following words : *If these formalities are attended to neither by the consignee, nor by a third party named by the consignor in the way-bill, then the railway is bound to attend to them.*

5° *Collection of the cost of carriage and correction of rates wrongly determined.* — In order to generalize the practice which already obtains in most international traffic relations, paragraph 1 of article 12 received the addition : *any part of the cost of carriage may be paid in advance.*

Moreover, paragraph 4 of article 12 was amended, to the effect that if the railway discovers any irregularity in the application of the tariff or error in the calculation, *The party concerned must be informed thereof as soon as possible.* The conference considered, with the proposers of this clause (Austria and Hungary), that such a clause was justified in the commercial interest, all the more so as it is already inserted in some of the tariffs. In order to prevent it from degenerating into a measure of red tape, it was recorded in the minutes that it is allowable, when a railway takes such action, to do so either by writing, by calling, by telephone, or by any other method.

6° *Charges forward* (art. 13). — In order to obtain a closer agreement between the German text and the French text, it was decided to replace in paragraph 1 the word “*Nachnahme*” by the words “*Nachnahme nach Eingang*”; moreover, the second sentence of the same paragraph, stating that charging forward can be refused in the case of goods for which the railway can demand the cost of carriage in advance, was struck out. It was also decided that it should be definitely stated that the consignor is authorized generally, and consequently also, in the case of goods for which the carriage must be paid in advance, to place charges forward on the consignment up to its value.

Moreover, the following new paragraph 5 was added to article 13 :

*Disbursements can only be made in accordance with the regulations in force on the railway in question.*

The authorization to make disbursements, it is true, is already implied by the wording of the way-bill; it was, however, found advisable to state this in the convention proper.

7° *Procedure in case of interruption in the carriage.* — In order to lay down a proper legal basis for answering the question whether, if one of the impediments to carriage provided for in article 18 turns up, the railway is entitled to claim the repayment of the extra charges resulting from the carriage of the consignment by another route, it was decided to add at the end of paragraph 3 of article 18, in accordance with subdivision 5° of the supplementary common conditions of article 18 laid down by the international railway union, the following clause :

*In case the consignment is conveyed to the receiving station by another route, the railway is entitled to claim the payment of the supplementary charges.*

8° *Procedure in case of impediments to delivery.* — Germany, on the one hand, and Austria and Hungary on the other, had drawn up proposals tending to safeguard the rights of the consignor and to compel the railway to advise him by wire if there was any impediment to the delivery of quick freight consignments, of animals and of perishables.

The preparatory commission thought that the duty of advising the consignor by wire if there was any impediment to the delivery of goods should also apply to slow freight when the consignor has given instructions to this effect in the way-bill. The conference adopted this view, and while generally approving the proposals submitted, it gave to paragraph 1 of article 24 the following form :

*When there are any impediments to the delivery of a consignment, the delivering station must inform the consignor without delay, through the medium of the sending station, and ask for his instructions. This must be done at once, by wire, if a demand to this effect has been entered in the way-bill. The cost of this operation is a charge on the consignment. If the consignee refuses the consignment, the consignor has the right to dispose of it, even if he is unable to produce the duplicate of the way-bill. In no case can the consignment be sent back without the definite consent of the consignor.*

9° Amounts to be claimed in case of delay in the delivery of consignments, under special declaration. — As it sometimes happens that in carrying out the existing provisions of article 40 of the international convention, a smaller amount of compensation is paid than if there had been no special declaration, Austria and Hungary proposed that *if in any case the declared amount is less than the total cost of carriage which would have had to be refunded provided there had been no special declaration, the latter amount can be claimed.* This proposal was adopted without opposition, but in a slightly modified form.

As regards article 58, an entry was made in the minutes, as showing the point of view of the conference, that *the time of 1 month as provided in article 58, paragraph 2, must be reckoned in such a way that the admission of a new railway to the international transport service takes place after the end of the day having a date corresponding to that on which the notice was given; or if there is no such date in the months in question, after the end of the last day of the month. Thus, if the notice is dated January 25, the admission is when February 25 has ended. Similarly if the notice is dated January 30 or 31, the admission is when the last day of February has ended.*

Article 6, paragraph 1 (clause 1-3°), article 10, paragraph 3, article 15, paragraphs 2 and 5, article 16, paragraph 2, and articles 17 and 45, paragraph 1, were only altered in wording; it is not necessary to consider these alterations in this place. Some of the alterations were mere improvements in the French of the German text; then also the wording of way-bills and the form for the ulterior disposal as provided for in article 15 have been modified.

#### **b) Regulations laid down for carrying out the convention and appendices.**

Chapter 1 concerning objects not carried or only carried conditionally was not drawn up sufficiently clearly, and did not sufficiently agree with the provisions contained in 3° and 4° of the supplementary convention of July 16, 1895; it was therefore proposed to recast it, and the proposal was adopted.

In this connection, the "final provision" of appendix 1 (provision concerning articles carried conditionally), which had been adopted at the Paris conference, received, in paragraph 1, the following amended form :

*Two or more or even all the contracting States may decide, by special agreement, that certain articles excluded by the present international transport convention may be admitted under special conditions or that the articles named in appendix 1 may be carried under less stringent condi-*

tions. These agreements may be arrived at by mutual correspondence or as a result of a technical conference called for the purpose. In all cases, the intermediary of the Central Office of international railway transport at Bern, may be sought. The administrations of the railways concerned can also, in their tariffs, admit certain articles not carried, or impose less stringent conditions than those under which articles only admitted conditionally are carried, provided :

- a) That the home regulations allow the articles in question to be carried, or admit the specified conditions which are to be applied to such articles ;
- b) That the tariffs drawn up by the administrations of the railways are approved by all the authorities concerned.

The extension given to this provision is that the procedure is to be followed when agreements are made between the contracting States for facilitating their reciprocal traffic is defined more clearly ; either by correspondence, if necessary by the intermediary of the central office, or as a result of a technical conference called for the purpose. In this way, was resolved the proposal made by Switzerland, that the provisions applying to articles accepted for carriage under certain conditions should be developed without break, even in the intervals between the periodic revision conventions. The proposal of appointing a permanent technical commission for the purposes of continuing this interrupted development was supported by nobody. The proposal of re-arranging the numbering of appendix 1 was also rejected, owing to the practical consequences this would have.

§ 2. *Form of the way-bill.* — Apart from the provision, already previously modified, concerning the red band on quick freight way-bills, it was decided that *when goods which have to be loaded by the consignor are handed over for forwarding, he has to enter, in the space provided for the purpose, the number and the marks showing the ownership of the wagon.* Then the following provision (identical with 3° of the supplementary common conditions of article 6) was added in the form of a new paragraph :

*If in one and the same place there are stations belonging to different administrations, or if there are stations having the same or nearly the same, name, the consignor is bound to enter the name of the receiving railway, in the space provided in the way-bill for the purpose.*

This last provision has in the first place the object of bringing the regulations in existence into agreement with the actual form of the way-bill. The other modification, of replacing " owner " by " marks showing the ownership ", is due to the wish of avoiding confusion and complaint as much as possible.

§ 3. *Excess rates.* — Modifications in wording were made in paragraphs 1 and 4 of this chapter. Paragraph 1 was brought into agreement with the new chapter 1.

In connection with paragraph 4, the following should be mentioned :

An elucidation seemed desirable in order to do away with what doubts had arisen on the question of knowing whether, by the present wording, " allowed loading of wagon " meant the upper limit of the load — in the case of paragraph 5, clause *a*, the normal weight of the load or the tonnage plus 5 per cent, and in the case of clause *b*, the tonnage marked — or the lower limit of load — in the case of paragraph 5 clause *a* the normal weight of the load or the tonnage without any increase, and in the case of clause *b* the normal weight of load marked. Consequently the first sentence of paragraph 4 has been worded as follows :

*In case of overweight of a wagon loaded by the consignor, the excess rate will be six times the*

*rate of the carriage from the sending station to the receiving station of the weight in excess of the higher of the two limits specified in paragraph 5.*

§ 6. *Time limit for delivery.* — Improvements have been made in the wording of paragraph 4 containing the provisions concerning the mention of the cause and the length of the increase of the time.

Paragraph 5 of chapter 6 of the regulations states that the time of delivery is kept either if the consignment is delivered or advice of its arrival is given, whereas the paragraph makes no stipulation of the keeping of the time of delivery of goods which must neither be delivered at a given address, nor advised. In order to provide for this omission, it was decided that subdivision 2 of the supplementary conditions of article 14 should be added in the following terms, and in the form of paragraph 6 of chapter 6 :

*In the case of a consignment where no advice of arrival is sent and which is not delivered at a given address by the railway, the time of delivery will be kept if before this has expired the consignment is placed at the disposal of the consignee at the receiving station.*

§ 7. — In order that there may be no doubt as to the form of *the ulterior disposal by the consignor*, as provided for in article 15, it was decided that these provisions should be subject to the same rules as specified in chapter 2, paragraphs 2 and 3, concerning the regulations as to the form of way-bills.

§ 8. — On the proposal of Russia, hog's bristles, horse-hair, wood, flax and hemp, manure, earth and coals were added to *the list of dry goods in which an allowance of 2 per cent in the weight, to allow for variation on the road, is made.*

§ 9. — Attention was drawn to the fact *in determining the extra rate for the time of delivery of consignment under special declaration*, as laid down in accordance with the existing paragraph 2 of chapter 9, this includes in most scales an amount which is a little larger than the maximum amount arrived at by applying the provision in question. This anomaly ceases if the supplementary rate of 25 centimes (2·4 deniers) per indivisible fraction of 10 francs (8 shillings) and 10 kilometres (6·2 miles) is only considered as basis for calculation and not as a maximum amount which may not be exceeded. Paragraph 2 of chapter 9 was modified to this effect.

The discussion of proposals for modifying *the existing provisions concerning articles accepted for carriage under special conditions* took up much of the time of the conference. The latter adopted most of the conclusions of the commission appointed to examine these proposals. As for the modifications, they had as object to harmonize the provisions of appendix 1, with the conditions of development of industry and traffic, and to extend, to the whole field to which the international convention applies, the facilities recognized as admissible by experience or which at present only applied to a limited field. The chief basis of this work was the German-Swiss convention of December 12, 1891.

The following numbers were altered, either wholly or in part, in this way :

- VI. Ordinary phosphorus and red phosphorus, calcium phosphide, mixture of red phosphorus with rosins or fats, phosphorous sulphide;
- VII. Sodium sulphide and material which has been used for purifying coal gas, coke with soda added;
- IX. Sulphuric ether and solutions of nitrocellulose in sulphuric ether or other mixtures;

- XI. Pyroxitic spirit and acetone;
- XV. Liquid mineral acids of all kinds, particularly sulphuric acid, oil of vitriol, hydrochloric acid, nitric acid, and sulphur chloride;
- XVI. Caustic lye, oil residues and bromine;
- XVII. Strong nitric acid and red fuming nitric acid;
- XVIII. Anhydrous sulphuric acid;
- XIX. Varnish and colours prepared with varnish, ethereal oils and fats, etc.;
- XX. Petroleum, oils obtained from lignite tar, oils obtained from coal tar and hydrocarbons;
- XXI. Petroleum, oils obtained from lignite tar, oils from peat and shale, petroleum naphtha and products of its distillation;
- XXII. Petrol and similar products;
- XXIII. Oil of turpentine and other oils having a bad smell;
- XXV. Arsenical liquids;
- XXVI. Other poisonous metallic products, copper sulphate and its mixtures;
- XXXI. Wool, hair, artificial wool, cotton, silk, flax, etc.;
- XXXII. Animal matters liable to putrefaction, such as raw hides, fats, etc.;
- XL. Gun cotton in pads and gun cotton for collodion;
- XLIV. Liquefied gases;
- XLVI. Methyl chloride and ethyl chloride;
- XLVII. Phosphorous chloride, phosphorous oxychloride and acetyl chloride;
- L. Mixtures of spirit of turpentine, alcohol or other easily inflammable liquids, with rosins;
- LI. Greased or oil paper and cases made of such paper;
- LIII. Fresh calves' rennet;

The following numbers are *new* :

- XVa. Sulphuric acid residues obtained in manufacturing nitroglycerine;
- XVb. Electric accumulators containing liquid;
- XXVIa. Potassium cyanide and sodium cyanide, solid and in solution;
- XXIX. paragraph 4. (Wood charcoal in lumps, not powdered);
- XXIXa. Mineral black;
- XLIIa. Percussion caps and fuses;
- XLIVa. Liquid air;
- XLIVb. Carbonic acid and acetylene, in the gaseous form;
- XLVIIIa. Sodium and potassium;
- XLIXa. Sodium peroxide and barium dioxide;
- XLIXb. Calcium carbide;
- La. At aniline works, greasy iron or steel filings and turnings and residues obtained when reducing nitrobenzol at aniline works.

\* \* \*

A number of proposals were *rejected* by the conference, either absolutely, or because the majority thought that the time for inserting them in the international convention had not yet arrived, or because they were simply the natural consequences of existing provisions, and therefore superfluous. Of these proposals, we may mention the following :

In order to remove any doubt as to what tariffs must or may be specified in the way-bill, it was proposed to give article 6, paragraph 1, clause *e*, the following wording :

*e) Specification, by consignor, of the tariffs which he wishes to be applied.*

*If the consignor asks for the application of a special tariff in accordance with the conditions specified under articles 14 and 35, he must expressly state this in the way-bill.*

This proposal was rejected, because the form of way-bill in use allows clause *e* to be interpreted in the sense proposed, and because in fact all the contracting States accept this interpretation.

It had been proposed, article 7, that the *full weight of load entered on the way-bill should be accepted as correct, if when the weight was checked on the weighbridge of the line an increase of not more than 2 per cent was recorded.* This proposal was rejected owing to the difficulties which would have resulted, in some of the contracting States, if it had been passed, and also because article 7, paragraph 3, reserves to each State the right at all times of issuing regulations as to the way the weight of goods is to be determined and checked.

A proposal bearing on article 7, paragraph 2, was made by Russia, *that a request to check the contents of a consignment should be sent to the party concerned only in the cases where such a checking is effected at the sending or at the receiving station.* The argument opposed to this was that it would limit the rights which those interested now have, and that moreover experience having shown that checking en route was very exceptional, the need of any modification was not apparent; the proposal was rejected on these grounds.

Another proposal made by Russia was to add to article 8, paragraph 2, the following clause :

*If the local conditions of the State concerned make it impossible to carry out these provisions, the stamping of the way-bill is carried out in accordance with the laws and regulations in force on the sending railway.*

The reasons brought forward were that to carry out the provisions of article 8, paragraph 2, according to which the stamping of the way-bill must take place at once after the whole consignment has been handed in, is against the Russian law, which specifies that if the goods are accepted for carriage and received at the yard, the stamping takes place as the goods are sent off. As against this, it was urged that the cases when goods cannot be sent off at once and must consequently be accepted for temporary storage, are provided for in article 5, paragraphs 2 and 3, of the international convention; and that article 8 specifies that the stamping of the way-bill only takes place, in the case of such consignments, when they have been received for carriage; no alteration in the convention is therefore necessary in order to give effect to the objects of the proposal. On these representations, the proposal was withdrawn.

The addition proposed to paragraph 2 of article 11, that the *cost of repair for protecting from damage the other goods as well as the wagons should be considered expenses which the consignor has to repay*, was rejected, in as much as the list of charges which the railway has the right to demand repayment of is by no means limited to the terms of article 11, paragraph 2; moreover article 9, paragraph 3, gives the railways the right to indemnification, by the consignor, for damage resulting from non-apparent defects.

As regards articles 25 and 44, it was observed that there is no existing provision specifying this procedure when loss or damage is discovered while the goods are en route. It was answered that article 25 specifies that examinations should also be made, the case arising, at intermediate stations. The delegates of the State who had made the proposal, withdrew it subject to the insertion of this opinion in the minutes.

It was mentioned, in connection with article 31, paragraph 1-3°, that in practice the railway nearly always comes to an agreement, regarding the *loading*, with the consignor, and regarding the *unloading*, with the consignee, and that therefore this procedure should be given a legal basis by adopting a corresponding amendment. The commission thought that the amendment proposed had disadvantages from the legal point of view and that it did not satisfy any real want. Any arrangements made between the consignee and the railway are outside the contract of carriage and consequently are not within the scope of the international convention; they are certainly out of place in the way-bill. The conference adopted the conclusions of the commission.

The proposal (corresponding to one of the regulations in force on the German railways) to add to article 31 that the *absence of responsibility of the railway, specified in subdivision 1° of paragraph 1, does not apply to extraordinary reductions in the weight or to the loss of entire packages*, was withdrawn, as this addition appeared unnecessary; this is more particularly shown by the French wording of the subdivision in question, where only "avarie" is in question. The same happened in the case of the proposal to add to article 31 a new paragraph 3 to the effect that *absence of responsibility as specified in article 31 cannot be claimed if the damage has been caused by fault of the railway*. The prevailing opinion was that considering the wording of paragraph 2 of article 31, the legal position of the consignors would have suffered by the proposed addition. Moreover, it was expressly recognized that if the fault was the railway's, the responsibility of the latter was determined by article 30.

As to the proposal to add to article 43 a proviso that the *railways are also not responsible for the loss a consignor may suffer if goods are accepted for carriage which are not allowed to be imported into or carried in a given State*, it was pointed out that under article 2 paragraph 3° of the international convention, the provisions of the latter do not apply to objects the carriage of which is prohibited, by law, in the State in question. The railway which nevertheless accepts such a consignment with an international way-bill, commits a fault for the consequences of which it is responsible. But the regulation of the resulting questions must be left to the home legislation of the State, and not be submitted to the international convention. — The proposal was withdrawn.

The same happened with a proposal to replace the first paragraph of article 44 by the following provision : *The receiving of the goods forms a bar to any claim against the railway*. When the convention was established, the point of view was taken, with good reason, that the receiving of the goods and the payment of the charges must, in the first place, have taken place before any claims against the railway can become barred; and in this case, it matters little whether it is the consignor or the consignee who has paid the charges.

Italy had proposed to supplement article 50 by a proviso that *assignment from one railway to another can be by registered letter*. It was thought that this point was not opportune and it was decided to remit it to the central office for consideration.

As regards article 57, Switzerland had proposed to insert, in the international convention, a provision for extending the arbitral functions of the central office to the relations between the railways and the public.

During the conference, the proposal took more definite form that the following new subdivision 4° should be added after subdivision 3° of paragraph 1 of article 25 :

*4° To give decisions, at the request of the parties concerned, in litigation which may arise between a railway and another party, in so far as the application of one of the provisions of the international convention is concerned.*

*The Swiss federal council is authorized to fix, in the procedure to be followed at the central office, the minimum sum in dispute, with regard to which the central office can be called upon to arbitrate.*

The deliberations of the commission are summarized as follows in the report :

“ The Swiss delegation is of opinion that this proposal is in the interests of the public as well as of the railway, as it gives the parties concerned the means of arriving at a satisfactory and quick settlement, at a small expense to them. The proposal by no means encroaches on the sovereign rights of the contracting States, as the central office can only arbitrate if the two parties agree on arbitration; moreover, the central office is already entitled, in accordance with subdivision 3° of paragraph 1 of article 57, to give decisions, when requested by the parties concerned, on disputes which may arise between railways; and this provision equally applies in case of a dispute between railways in one and the same country. Taking into consideration that it is a question of arbitration to which the parties concerned submit of their own freewill, no special importance can attach to the fact that according to the home legislation of some States, the arbitral decision of the central office cannot be carried out without other formalities.

“ The commission does not think that it can support this view. It expresses its opinion as follows : Without considering the objections, from the point of view of sovereign rights, against making the central office the permanent arbitrator between the public and the railways, the need of giving the central office this qualification has not made itself felt. It cannot *a priori* be admitted that the central office will be able to give quicker, or more inexpensive, or better decisions than the regular tribunals. The impossibility of at once carrying out the decisions of the central office must also be taken into consideration, as well as the difficulty resulting from the fact that not only the first railway and the consignor or consignee, but also all the subsequent railways take part in the dispute. Finally, uniformity in the law will be endangered rather than strengthened. ”

The conference rejected the proposal, but entered the following declaration in the minutes :

*There is no actual objection against members of the central office acting, in their personal capacity, as arbitrators, when requested to do so by the parties concerned. The decisions must not be inserted in the “ Bulletin de l'office central. ”*

It had been proposed, in connection with chapter 2 of the regulations, to issue an instruction for the method of recording the statement relative to the payment of carriage in the way-bill, an instruction drawn up as a supplementary condition by the international transport committee, and the commission was in favour of this. But the conference, taking into consideration that the provisions in question are already in force on the railways which are under the international transport committee, acknowledged the objections raised by the Russian delegates and rejected the proposal.

The conference also *rejected* the following proposals concerning *chapter 3 of the regulations* :

- a) To calculate the excess rate, in the cases enumerated in paragraph 1 of chapter 3, in the same way as in the Italian tariffs, that is to say proportionally to the rate for carriage;
- b) To reduce the excess rate, in case of excess weight, to half the amount fixed in paragraph 4 of chapter 3.

The same happened with the proposals concerning *chapter 6 of the regulations* :

- a) To extend to the return of the repayments, the times specified in paragraph 1 for all quick freight goods — inasmuch as the regulation period proposed would often be longer than the time actually occurring in practice, and its acceptance would allow the present disadvantages to continue to exist;
- b) To compel the railways to state in the way-bill the time not included in the time for delivery because such time is required for carrying out the custom-house, the octroi or the administrative formalities, or is the result of an interruption in the traffic for which the railway is not responsible — inasmuch as this proposed reform would meet with great difficulties in practice and would result in great delays in the regular despatch of goods.

We consider it unnecessary to enumerate sundry proposals which were withdrawn, without discussion, by the delegates of various States, as also those which were not discussed because they were only brought forward during the conference, for instance the proposal to settle at what place the next conference should meet.

\* \* \*

The conference also dealt with two proposals concerning *article 1 of the regulations on the central office*, which were made, the one by Germany, the other by Switzerland. They only concerned the internal working of the office and are consequently of no interest to the public.

\* \* \*

The following were not discussed :

- 1° A proposal from Russia, to insert in article 57 of the international convention a new paragraph that the central international transport office should compile and publish international railway statistics;
- 2° A proposed international convention concerning the transport of passengers and luggage on railways, which had been worked out by the Swiss Federal Council.

As regards the first proposal, it was objected that no preliminary work had been done and that it was not known how much work it would involve and what difficulties there would be in carrying it out. Moreover the time at which the proposal was made to the governments of the contracting States hardly enabled them to arrive at any determination on the subject.

The proposed convention concerning the transport of passengers and luggage also could not be considered; it was thought that before discussing at the conference a separate convention on the transport of goods by railway, it was in the first place necessary to proceed to an interchange of opinions between the governments of the contracting States.

# PROCEEDINGS

OF THE  
SEVENTH SESSION

WASHINGTON : MAY, 1905

---

3<sup>rd</sup> SECTION. — WORKING.

---

[ 686 .256.3 ]

QUESTION X.

---

## AUTOMATIC BLOCK-SYSTEM

---

*What are the recent improvements in automatic block-signalling apparatus,  
and what progress has been made in their introduction?*

**Reporters :**

*America.* — Mr. C. H. PLATT, general superintendent, Western District, New York, New Haven & Hartford Railroad.

*Other countries.* — Mr. M. MARGOT, ingénieur adjoint à la direction de la Compagnie des chemins de fer de Paris à Lyon et à la Méditerranée.

## QUESTION X.

---

## CONTENTS

---

	Pages.
Sectional discussion . . . . .	1549
Sectional report . . . . .	1570
Discussion at the general meeting. . . . .	1570
Conclusions . . . . .	1575
Appendix : Supplement to report No. 1, by C. H. PLATT . . . . .	1577

### PRELIMINARY DOCUMENTS.

Report No. 1 (America), by C. H. PLATT. (See the *Bulletin* of September, 1904, p. 1003.)

Report No. 2 (other countries), by M. MARGOT. (See the *Bulletin* of December, 1904, p. 1613.)

Vide also the separate issues (in red cover) Nos. 8 and 16.

## SECTIONAL DISCUSSION

---

Meeting held on May 9, 1905 (morning).

---

MR. H. TYLSTON HODGSON, PRESIDENT, IN THE CHAIR.

**The President.** — I now call upon Mr. Platt to summarize his report on the automatic block-system.

**Mr. C. H. Platt, reporter for America.** — The subject of this report, does not suggest discussion as to the merits or demerits of any principle in signalling, or as to any type of signals as compared with any other. The usual *résumé* of varying opinions on different questions included in the general subject under consideration cannot, therefore, be presented by your reporter according to the prevailing practice of reporters on other questions.

Our question calls for statements of fact under two heads :

- 1° What are the recent improvements in automatic block signalling apparatus?  
and
- 2° What progress has been made in their introduction?

Recent improvements have been considered to mean since the date of the report to the sixth session of the Congress held in Paris in 1900.

The statements contained in the first subdivision are based on information furnished by signal companies making such improvements, the almost universal practice in America being that such companies furnish, and in most cases, install, signalling apparatus ready for use.

Many improvements or so called improvements have been brought to the attention of your reporter, but only those considered to have passed the experimental stage are included in the report submitted for your information and consideration.

The second subdivision contains tabulated statistics furnished by the several railway companies giving the progress in the introduction of automatic signals, and the results obtained in their operation. Great care has been taken in analyzing the causes of failure as reported by the several companies to consolidate them under the several heads adopted and found in the tables, your reporter necessarily assuming that the records of the number of signal movements and the causes of failure were carefully made and accurately reported in each case.

The introduction to report No. 1 for America states the action taken or conclusions arrived at by the Congress since the subject was first introduced at the session in Brussels in 1885, to and including the Paris session in 1900.

Subdivision A contains descriptions with illustrations of recent improvements under the headings of the various signal companies introducing them, and as the printed reports are before you these need not be even recapitulated at this time.

Subdivision B contains the tabulated statistics already sufficiently referred to.

The closing paragraphs give the conclusions recommended for adoption as follows :

1° That automatic signalling, properly designed and installed, be recognized as a suitable means of protecting train and switching movements;

2° That any automatic signal system, effectually providing that the signals for any block cannot indicate safety before the last vehicle of the last train which may have been permitted to enter the block, has cleared the same, be approved.

Your reporter is deeply impressed with the thought that these or similar conclusions should be adopted for the reason, among others, that the previous conclusions reached by the Congress have either been unfavorable or noncommittal. It is true that the previous conclusions have resulted from want of complete and practical knowledge of, and experience with, automatic signalling as developed to-day. The magnitude of such operations, and the results now obtained, remove any doubt that may have been entertained earlier in the development of automatic signalling, as to its efficiency and practicability for protecting train and switching movements under conditions that prevail on a large number of railway lines.

The question whether automatic, or some form of manually controlled signalling should be adopted on any particular line, or under given conditions is not at issue. This must be left to the management of each and every line, and decided for itself according to its conditions and requirements.

On the other hand, there is no doubt that automatic signalling has reached such a stage in its development that it now holds a very important place in the signal systems of the world, being found after years of experience, and reaching over 400 millions of movements per annum in America, and rapidly increasing, to be an efficient and satisfactory method of protecting traffic with safety and economy, and should now have the favorable and unqualified endorsement of this the highest railway authority of the world.

The supplemental report for America contains a statement of the number of signals installed and under contract since the close of the first report prepared in September, 1903, as furnished by the several signal companies.

It will be seen by comparing report No. 1 with the supplemental report for America that great progress has been made during the last year and a half in the number of signals, the number of signal movements, and in the reduction of failures, in proportion to the movements.

Much is to be done along the latter line, and can be, by greater care in inspection and maintenance. This in turn means greater expenditure for more employees or a higher class of men employed. It should be borne in mind, however, that an occasional stop on account of a signal failing to clear when the block is clear is not a serious matter, especially on lines of slow speed and light traffic, and many managements may conclude that it is not advisable to make the necessary expenditure to bring the service up to a higher standard, especially where no danger is involved. These facts, however, apply to manually controlled as well as to automatic signalling.

The automatic apparatus of to-day makes it easily possible to maintain a practically perfect service, only subject to such derangements as apply to all kinds of signalling known.

For the year ending September 1, 1903, there were 166,076,113 signal movements reported as compared with 405,527,231 movements for the year ending December 31, 1903, while the number of failures (signals not clear when block was clear) were 14,435 and 19,062 respectively. False clear indications 268 for the former and 186 for the latter year.

The number of signal movements increased 144 per cent.

The number of failures (block clear signal not clear) increased 32 per cent.

The number of failures, false clear indications, decreased 30 per cent.

The average number of signal movements per failure, block clear signal not clear, all causes, increased 103 per cent.

Taking the failures not clearly traceable to causes outside the signal apparatus, as reported, we have 195,872 movements per failure, block clear signals not clear, and 13,097,343 movements per false clear indication, a record that will compare favorably with any system of signalling anywhere in use.

These results have been obtained from all automatic signals in operation during the year specified, many of the signals in use being of older types which are far short of the present standards, some of them being of the original type in use for about thirty years.

The supplemental report, now before you, calls special attention to two new devices; one of them the Kinsman automatic train stopping device, is shown, and demonstrated by a full working model, at the railway appliance exhibition of Washington, and need not be further referred to here. The other, the Harrington automatic signal system may be briefly described as follows. The apparatus includes: 1° the use of an hydraulic accumulator; 2° a pump, worked by an electric or other motor, for charging the accumulator; 3° a new arrangement of circuits for controlling the signals on electric railways where the rails are employed for the return of the current; 4° a combination of parts so that the arm of the semaphore occupies an intermediate position between "danger" and "line clear," if for any reason the signals or their appliances are not working; 5° an illuminated semaphore arm which gives a night position signal.

The pump which is worked either by the direct mechanical power derived from the wheels of passing trains, or, as in the test installation by an electric motor deriving current from the third rail, or from the feeder, of an electric railway, provides the accumulator with a charge sufficient for 50 or any predetermined number of signal movements. When the charge limit is reached, the pump stops working automatically. The transmission agent which works the semaphore arms is non-congealable fluid in the accumulator applied by pressure. When the accumulator has moved the semaphore 45 times, for instance, the pump automatically begins to work again and recharges the accumulator to its full capacity, as mentioned above. If, for any reason, the charge of the accumulator falls to zero, the signal necessarily and automatically assumes the intermediate position. Thus trains are never obliged to run through a signal standing at danger. Nor need they stop at a signal which is not working, because the position of the semaphore arm tells a driver that the signal is out of order and moreover acts as a warning to him to run cautiously, under the rules.

As you will gather, great advances have been made since the meeting of the Congress in 1900.

Automatic signalling systems have been introduced on a large scale in America. Automatic signals are greatly preferred by those who have tested them; they have been adopted even on lines where traffic is heaviest and everywhere they provide the utmost security. They can therefore be recommended not only from the standpoint of satisfactory operation, but also from that of the cost of installation. (*Applause.*)

**The President.** — I shall now ask Mr Margot, who is the assistant traffic superintendent of the Paris Lyons and Mediterranean Railways, to give a summary of his paper.

**Mr. Margot, reporter for all countries except America.** (In French.) — Gentlemen, you have just listened to some most interesting remarks upon the improvements introduced in the United States, of recent years, in the apparatus of automatic signalling and upon the growth of this method from day to day.

The same is not true of the other countries to which my report applies, but I now have the honour to submit a summary of my report.

The question of automatic signalling upon which it was my business to report for countries other than America, runs as follow in the agenda of this meeting :

*What are the recent improvements in automatic block-signalling apparatus, and what progress has been made in their introduction?*

When the question of automatic block-signalling was discussed at the meeting of the Congress in 1900, the Paris-Lyons-Mediterranean had only just completed putting in a Hall block plant on its Laroche and Cravant line (38 kilometres [23·6 miles]). At the same time, about 1900, the Southern of Austria was experimenting, on a short section, with an automatic system brought out by a Budapest Electrical Company.

Since then, the French Midi Company has introduced the Hall system on its line between Bordeaux and Langon (42 kilometres [26 miles]). Two installations, also of the Hall pattern, were fitted up more recently in England for short distances by the London and South Western and the North Eastern companies.

The whole experience applies to only five installations with a total length of 119 kilometres (74 miles), which means about  $\frac{3}{1000}$ <sup>ths</sup> of the mileage operated on the block-system in all countries other than America. This is a contemptible figure when compared with the example afforded us by the United States, for at the present time America has thousands of kilometres operated by automatic signalling.

Why do not other countries follow this lead? The question naturally occurred to me, and this is what induced me to enter upon an investigation to compare automatic with non-automatic signalling, having regard to the conditions of operation.

But before broaching this subject, kindly allow me to summarize briefly the results of the trials of automatic signalling on the Paris-Lyons-Mediterranean and the Midi railways with which trials the first part of my report is taken up.

The automatic block employed on the Laroche and Cravant line (38 kilometres [23·6 miles]) and on the Bordeaux and Langon line (42 kilometres [26 miles]) is the Hall system. Its principles are well known; it is used on both lines, the track being normally closed.

The Paris-Lyons-Mediterranean has applied the Hall system to its ordinary signals by means of dynamos worked by batteries, while the Midi railway has adopted out and out the American signals of the Banjo type.

On the Midi, experience has proved that in practice the drivers soon and easily accommodate themselves to the special conditions of visibility, though they are very different from those of the target or semaphore signals to which they are accustomed.

But there is still a dubious point, namely, how well the signals show up in time of snow or hoar-frost, when the central opening of the Banjo signal may be covered with an opaque layer. If this has not happened on the Midi of France, it must none the less be seriously considered by railways less favourably situated from a climatic standpoint, and it would be interesting to hear what information American engineers can give us on this subject.

As regards the electrical equipment of the track, the Paris-Lyons-Mediterranean has retained its ordinary angle fish-plates, insulating them with pieces of fibrous material. The Midi has used wooden fish-plates. The latter have lasted very well according to the experience of two years on a line where speeds reach as high as 120 kilometres (74·5 miles) an hour.

The electrical equipment of the track is no trouble except in replacing rails, and then only when they are being renewed on a large scale.

I now come to an important subject, namely derangements in the working of the apparatus.

Apart from the theoretic safety required of the block-system, there is the practical safety which depends on the regular working of the apparatus. Any derangement

stops the trains and causes delays which react upon the traffic, so much so that it is of the greatest importance that it should be quickly noticed and put right. Seeing that in the automatic block, it is no longer the signalman who instantly notices a derangement and can set to work to see that it is put right, there can be no doubt that derangements of the automatic block may have a more marked effect upon busy traffic than those of the non-automatic block; and consequently we are justified in expecting from automatic signalling a higher degree of perfection in the working of the apparatus.

Now, from the standpoint of working, the results afforded by the Paris-Lyons-Mediterranean and Midi installations are not yet, it would appear, sufficiently satisfactory. There has been some inevitable groping about in the dark which must be neglected, but it is certain that at present the number of failures with the automatic signalling is as low as with the various systems of non-automatic signalling in use upon the French railways.

As regards the cost of the automatic block, the two isolated instances of the Paris-Lyons-Mediterranean and the Midi do not justify figures being quoted. We can derive no more than an impression therefrom, and this is that the Hall system appears higher in first cost than the non-automatic block, owing to the expenditure on electric circuits, the electrical equipment of the track, etc. As regards working expenses, the Hall block unquestionably costs more for supervision and maintenance of the electrical fittings.

So then, the automatic block involves increased capital charges, higher first cost and greater expenditure on maintenance and supervision.

On the other hand, signalmen can be obviated. Now, if one can save altogether at a cabin the wages of the staff requisite for carrying on the service by day and by night, the gain will balance — and more than balance — the extra establishment and operating expenses. In such a case, there can be no question as to the advantage of automatic signalling.

But in many cases, no saving in men can be expected when the signalling is entrusted to the switchman at a point always watched, or to a gatekeeper, in fact whenever a man has to be on duty for other reasons. This is so true, that taking everything into consideration the monetary question resolves itself into the probable saving of wages that will result from giving up watchmen, and this depends upon the special features of the line and the organization of the service required of it.

Here my report would have ended if I had strictly adhered to the programme laid down by the actual wording of the question. I thought my mission ought to go a step further. As I stated at the commencement, it happens that in Europe automatic signalling has not got beyond the experimental stage, its applications being very few, while the American lines have gone deeply into automatic systems. I thought it of interest to determine the reason. This led me to take up the question thoroughly and to consider the conditions of its operation, as compared with non-automatic signalling.

For us in Europe who use the non-automatic block, and know by long practice the amount of safety afforded thereby, this comparison appeared to me likely to be of high interest. The following are the conclusions to which I was led :

The automatic block seems unquestionably a theoretically perfect solution when it uses the track circuit. This method, in fact, satisfies most completely the condition that there should be proper intervals between trains following one another on the same line ; it settles in a very simple way the individual instances of side-tracking and of couplings breaking. If a train breaks apart inside a section, the signals remain at danger as long as there is a pair of wheels in that section ; besides, a break-away running backwards protects itself by the action of the track circuit of the section engaged, by putting or keeping at danger the signals in front of a train advancing towards it. Lastly, the track circuit renders it possible for the block-section to exercise continuous control over the condition of the track, from the standpoint of fractures or removals of rails. These are all advantages inherent in the track circuit, and — be it said in passing — any block-system, even if non-automatic, which used this circuit would possess them too.

Nothing more perfect as a block-system can exist. Automaticity does away with human fallibility ; there is no longer any fear of the grave mistake on the part of a signalman in letting a train enter a section, going to sleep, waking a few minutes later and giving line clear to the preceding box, whereas in reality the train has not yet passed his box. Automatic signalling extirpates such mistakes, and the absence of the signalman is no disadvantage provided everything goes on normally in the block.

But we have to allow, in the first place, for the liability of apparatus to fail in practice and, in this respect, the automatic systems tried in France have not yet reached, in accordance with what I have told you previously, that pitch of perfection which must be demanded of automatic, still more than of non-automatic, systems. Secondly, untoward incidents are bound to occur in running trains.

Now as soon as such an incident occurs, either in connection with the working of the apparatus or in the running of the trains, the signalman, by his mere presence, affords an additional guarantee through the control he exercises over the train staff.

Furthermore, the signalman can in certain cases assist very materially in reducing to a minimum the trouble which results from a failure or a breakdown.

Lastly, apart from the actual signalling, the signalmen have the additional duties of watching passing trains and several railways can vouch for numerous instances in which their vigilance has proved valuable.

Thus the presence of signalmen distributed along a line with non-automatic signals affords, under conditions where the safety of the traffic may become involved, extra guarantees of the highest importance, especially on a trunk line.

The essence of automatic signalling is to do away with a man to watch the block. But there must be employees to give notice of trains to the cabins of junction sta-

tions and these will have to start the trains properly. Moreover, at service stations there must be a man to look after the running of the trains. Automatic signalling is not, indeed, left to its own devices except at open stations or at intermediate points, so that it does not always imply the saving in watchmen which is its essential feature. The question is one of local conditions.

On this point, I may with advantage quote the reply I received from the Belgian State Railways, for it summarizes all the others on the subject of automatic signalling.

The Belgian State Railway has Siemens block on 1,633 kilometres (1,015 miles). It has subjected the Hall system to careful examination on the Ghent-Wondelgem line (5 kilometres [3·1 miles]), where Hall apparatus had been put in before the line belonged to the State Railway system. The apparatus was removed because the route of the line was altered. There had been an idea of equipping another line, but this was given up owing to the following reasons :

In the first place, no economy of staff can be expected to result from the automatic system, when there are, as in Belgium, many signal stations, junctions and level crossings in connection with the block-system.

Then as regards the safety itself although there are good automatic apparatus which, when they work well, afford the same guarantees as the apparatus at present used, the inevitable failures must be taken into consideration, and then it is an advantage that the intelligence of a signalman can at once act as substitute for the appliance which has gone wrong. Moreover, the signalman exercises a useful control over the men in charge of the train.

There is another point. European railways can easily procure labour. It is comparatively cheap, can be got anywhere and is safe.

Hence naturally on lines already provided with a non-automatic system working well and giving complete satisfaction, there is no object in exchanging it at great expenditure for an automatic system. Especially on a main trunk line must we hesitate to lose the guarantees afforded by watchmen, whereas on lines not yet equipped with a block-system, automatic signalling may be an advantageous method of operation to introduce.

Under the circumstances involved in my report I have the honour of submitting to the Congress the following conclusions :

1° The automatic block-system, using a track circuit which substitutes the intervention of the train for human agency, satisfies most completely the conditions of working, from the technical point of view.

2° The automatic block has not yet attained any development outside the United States of America. Nevertheless some applications made on main lines are, at the present time, beyond the experimental stage. It has been observed, more particularly, that the track circuit is compatible with high speeds, without entailing appreciable difficulty in the maintenance of the track.

3° Practical experience in non-automatic block working has shown how desirable it is to have employees at intervals along the line, both on account of possible breakdowns in circulation of the traffic, of failures in the working of the signals and apparatus, and also in order to watch the trains; particularly is this important in the case of a trunk line. This consideration, when

applied to the automatic block, may, under different conditions, much affect the theoretical saving to be effected in the staff.

4° Regarding the working of the automatic block :

On lines already equipped with the non-automatic block, there is generally no advantage in incurring the expense of the change, at any rate under those conditions which apply to the working of lines outside the United States of America.

In the case of lines not yet equipped with a block-system, it may be found that the automatic block can be adopted with advantage, according to the particular conditions, the service to be organised and the economy of staff to be effected as compared with the non-automatic block. (*Applause.*)

**The President.** — Now, Gentlemen, these two papers have been read, and I would ask you to start in with a discussion on the subject.

**Mr. Riché, French Eastern Railways.** (In French.) — Kindly allow me to read a few remarks arranged by Mr. Piéron, traffic superintendent of the French Northern Railway, who is detained in another section :

“ Among the conclusions at the end of the report submitted by my friend and colleague Mr. Margot, after Mr. Platt's report, there is one or even two that I desire to support strongly in your presence, by dilating upon them from the standpoint that concerns myself.

“ They are worded as follows :

“ Practical experience in non-automatic block working has shown how desirable it is to have employees at intervals along the line, both on account of possible breakdowns in circulation of the traffic, of failures in the working of the signals and apparatus, and also in order to watch the trains; particularly is this important in the case of a trunk line. This consideration, when applied to the automatic block, may, under different conditions, much affect the theoretical saving to be effected in the staff.

“ Regarding the working of the automatic block :

“ On lines already equipped with the non-automatic block there is generally no advantage in incurring the expense of the change, at any rate under those conditions which apply to the working of lines outside the United States of America ”.

“ The French Northern Railway which I have the honour to represent at this Congress, works a line carrying a very heavy traffic, and thirty years ago it equipped its lines with a non-automatic block-system, but its successive sections are rendered dependent upon each other through interlocking arrangements. The company has about 3,800 kilometres (2,360 miles) of line, about 2,000 (1,240 miles) of which are double and the rest single track ; the block-system is at work on all the double lines and on about one third of the single lines. On the latter, more especially, the cabins are situated, with hardly a single exception, jointly with the stations and do not require any separate staff.

“ When this plant, upon which so far the expenditure has amounted to over 10 million francs (£400,000), was installed, various imperfections in the appliances were discovered, and the staff whose business it was to maintain them and the men

who had to work them had to be educated. This education of the staff is now thorough, and the service now satisfies us completely both as regards its regularity and as regards its safety.

“ If it were now necessary to alter what exists, in the midst of the extremely heavy traffic with which we have to cope, not only do we believe that we should be incurring an absolutely useless and thoroughly unjustifiable expenditure, but in addition we should find ourselves face to face with a responsibility that we could not undertake. I repeat that, with our heavy traffic, to recommence all the education of our staff to the use of new appliances, would involve during the necessarily long transitional period that must be gone through, an absence of security that we would by no means dare to face and that would finally not result in any improvement.

“ To sum up, I do not hesitate to assert that, not only on the lines of the Northern of France which are already all equipped with the non-automatic block, is there nothing to gain by incurring the expense of transformation, but further that, under the circumstances in which we are situated, this expenditure which would be very heavy and would not be justified by any compensating factor, would place us, as regards security, face to face with a responsibility, which in my opinion, constitutes an obstacle of quite prime importance ”.

These remarks are made on behalf of the Northern of France railway, and I should like to add a few in the name of the Eastern Company of which I am a director.

The subject assumes a slightly different aspect for the Eastern Company and this is true for each company. It might be summed up as follows : what ratio is there between human fallibility and the material fallibility of the appliances?

When traffic becomes dense and signal movements become more frequent, the value of mechanical appliances still remains practically the same. This is not always the case with human vigilance which may give out at any moment.

Comparisons must therefore be instituted, not only between the mechanical appliances themselves, but also between these latter and the machinery set in action by human agency. At the present time, we are perfectly satisfied with the non-automatic block-system installed on our lines, because we possess a good staff always on the look-out and capable of being recruited fairly easily. But in looking forward to the future, we realize that we may later on find ourselves obliged to increase the movements of our signals indefinitely, and that we may find it so impossible to get together an efficient staff that we shall be bound, to a greater or less extent, to introduce automatic signalling.

I therefore support the very broad conclusions suggested by Mr. Margot when they assert that though the automatic block-system possesses advantages, the non-automatic likewise possess some. These conclusions leave everybody full scope.

I should like to ask the delegates from the United States what is the exact result of the comparison drawn between the automatic and the non-automatic apparatus.

We are told that there are still in the United States some lines not equipped with

the automatic block system. I should like to hear whether there are still many such and, if so whether they are going to remain so.

**Mr. Th. Voorhees, Philadelphia & Reading Railway.** — Mr. President and gentlemen, it was my good fortune some fifteen years ago to be called upon to instal the block system of signals on the Hudson River Division for the New York Central & Hudson River Railroad, and we constructed 102 cabins in a distance of 142 miles, from New York to Albany. They were all constructed on the Saxby-Farmer plan, copied directly from the English practice, and were built by the Union Switch & Signal Company and by the Johnson Signal Company, both copying from the English methods, entirely a manually controlled block system intended to be used as an absolute block. We found in practice, the traffic being dense, that it soon became necessary to use the block permissively. We held our trains for one minute and then allowed them to proceed under control, knowing that the block was occupied. The Hall system had been known at that time and had been experimented with, but not sufficiently to justify the management of that road then to adopt it. A few years later, I went into the service of the Philadelphia & Reading Railway Company, and about ten years ago, it became necessary to introduce an improved system of block signalling there, and we adopted the enclosed disc, the Hall system. We found that that worked with very great success. We had at first, as the reporter indicates, a few cases of false indication, the banners being clear with the block occupied. That was due to the lightning fusing the points of the relay. As soon as that was discovered and the cause of it pointed out, it was corrected by the makers of the apparatus, and I think I may say with safety that for a number of years past we have had no such accident or failure. We also found in the beginning, in cases of severe storm, failure of wires and battery wells. The first battery wells were installed by the manufacturers in a somewhat cheap fashion. In all the installations we have made of recent years we have put our own battery wells, entirely aside from the contractors, and we make them of concrete, a solid, substantial structure, that is frost-proof, and our success has been so great that in the month of January, 1904, which was an exceptionally stormy bad month for railways in our Eastern country, we only had four failures of signals on our entire line.

I did not come prepared to talk, and so cannot give you accurate statistics, but we have about 1,400 miles of road. We have a very heavy traffic over our main lines, and we have perhaps between four and five hundred miles protected by the Hall system. On our branch lines where the traffic is less dense, we are using the ordinary manual block which is a temporary substitute, the intention being to gradually extend the automatic system of signalling throughout our entire system. I would say that we have no difficulty with regard to snow or ice, because we invariably accompany the danger signal with a distant caution signal, so that it really becomes unnecessary for the engineer to see a signal until he reaches it,

and in the most stormy weather, and with wet snow on the glass, if a man uses ordinary care as he approaches the distant signal, he gets the indication and he knows that the home signal demands his attention; and we put the distant signals in all cases a sufficient distance back to give the engineer ample time to stop his train.

**The President.** — Just to clear up one or two points in what Mr. Voorhees has said; fifteen years ago, I think you said, you started the Saxby-Farmer on the New York Central?

**Mr. Th. Voorhees.** — Yes, a system of that nature, copied from that, I believe it was.

**The President.** — Then it was ten years after that that on the Philadelphia & Reading the Hall system was started?

**Mr. Th. Voorhees.** — About ten years ago; about five years after.

**The President.** — Ten years ago that you started the automatic Hall system on the Philadelphia & Reading?

**Mr. Th. Voorhees.** — Yes, Sir.

**The President.** — Thank you.

**Sir Charles J. Owens, London & South Western Railway.** — Mr. Chairman and Gentlemen, a point has not been touched upon in our discussion at present which it has appeared to the London & South Western Railway would be an absolute condition precedent to the adoption of automatic signals, and that condition precedent has been the adoption of power signalling at the stations. We have found by the introduction of pneumatic and electric power at certain stations, that the number of signal boxes has been considerably reduced and the manual labor of the signalmen in moving the switches has been enormously revised, so that there has been effected a very great saving, but it has appeared to us at once that, having an installation of power at the station, it was a natural and a proper thing from such points to extend the automatic signalling, so that from a central station where we have a large business and where we installed the power signal at the station, the same power could very easily control a distance of six miles in either direction, thus giving us twelve miles controlled by one power house, and for such twelve miles we could have automatic signalling carried on with practically no additional expense at all for signalling.

So far as our feeling goes, it is that the field for automatic signalling is a distinctly limited one. We have in operation over our lines the absolute block system, and that we find quite sufficient where the traffic is of a light description; but where the traffic is of a heavy description and it is desirable to increase the number of sections by decreasing their length, there we have found and do find that the

installation of the automatic signal has been of very great benefit to us, indeed. It may be interesting to the gentlemen attending the section if I tell them that so far as we concerned, we have had no failure of our automatic signals except in the direction of giving the section blocked when the line was absolutely clear, and in those cases, we have found that it has been not through faults absolutely inherent to the system, but perhaps through lack of there being very efficient observation and care on the part of those entrusted with looking after the signals.

There is one point on which I should like to say a word in connection with the conclusions in Mr. Margot's paper, where he refers to the necessity for the staff keeping watch, in case of breakdowns of trains and other such difficulties arising, and also keeping a watch over the trains themselves. Now, so far as our working goes, we do not take our staff away from the stations, so that as far as trains are observed to see that they are complete and that everything is in order at the stations, the introduction of the intermediate automatic block signal does not reduce our security one iota. The idea that always prevails against automatic signalling, as far as watching trains at the station is concerned, has been overcome by the adoption in America of the corridor train and by the adoption in England of direct communication between the passenger and the guard, so that anything which may be wrong inside the train is very quickly ascertained. But we have taken one precaution which I think is a very useful one, and we have found worked to our advantage in many cases, and that is, that at the base of every automatic signal post we have instituted a telephone. Now, we have found that when the signals got out of order, if the train is stopped, the guard without any trouble at all gets out, he communicates with the nearest station, and all the necessary measures are taken for keeping the traffic fully at work. I think perhaps that may be a useful hint to some of our friends who may be considering the adoption of this system of signalling.

**Mr. Th. Voorhees.** — On the Philadelphia & Reading Railway, entering the city of Philadelphia at our Reading terminal station, we receive about 250 trains inbound and about an equal number out-bound each twenty-four hours, making nearly 500 trains to be handled in that station. The station and yard and the immediate approaches are all controlled by the Westinghouse electric-pneumatic interlocking and signals, and we have used that power, as Sir Charles Owens has suggested, for a distance of about a mile from the station. Some four or five miles out, we have a very large junction point where we have recently installed the low-pressure pneumatic interlocking, but we do not use that at all in connection with the signals. We found that it was much more economical to run the Hall signals right through all of our interlocking points than to undertake to combine them, and very much more economical than to use the electro-pneumatic which is a more complicated system in operation. On our Atlantic City road, which is 35-1/2 miles in length, we have between the termini only three points where there are interlocking cabins necessary, and we find it there very more economical to handle our traffic, which is

very heavy, but which consists entirely of through business from one end of the line to the other, by the use of automatic signals than if we were to undertake to install cabins and manually controlled signals at all the points necessary.

There is one other advantage which we find, while it is a minor one, that is worth mentioning, and that is, that the disc signal in all cases is a *block* signal. The semaphore working from a junction box or interlocking tower is a *route* signal, and there is immediate notice to the engine driver what each particular signal means.

**Mr. Bleynie, Midi of France Railway. (In French.)** — A few years ago, the question of the automatic block-system came, in a general way, before all the French railway companies, owing to the growth of the traffic on the main lines. Previously the Midi railway of France had not a single line equipped with a block system worked either manually or automatically. At a certain moment, we desired to instal a block-system and we were then induced to study the various systems being used in Europe and in America. Subsequent to our investigations, we experimented with the Hall automatic block on the section between Bordeaux and Langon which is about 42 kilometres (26 miles) in length. This system has been working satisfactorily for two years, in the sense that no failure in working the signals has occurred that could compromise safety. But there have been fairly numerous mistakes, especially in the way of showing line blocked when in reality it was clear. These derangements have involved trains being pulled up unnecessarily.

According to Mr. Platt's supplementary report (*see* appendix), the number of derangements showing line blocked whereas it was really clear would appear in America to be only one per 20,000 movements, whereas on the section of the Midi Railway between Bordeaux and Langon, the proportion has been about 3 per 10,000 movements with the Hall system.

Probably this vast difference in the number of derangements is due to the fact that we are still only beginners, and that the technical education of the staff charged with the maintenance of the apparatus and the track is not yet complete. But we hope to attain as good results as you do in America.

Many of these derangements have been, however, due to the air lines, requisite for carrying the current, getting entangled. But Mr. Platt states in his report on improvements lately introduced into automatic signalling, that it has been found possible to reduce the number of wires required for making the circuit, or even do away with them. This new arrangement would possess the advantage of diminishing or abolishing the entanglements that so often occur in the overhead wires and consequently the derangements of the block-system that arise therefrom. But the statistics supplied by Mr. Platt about the number of derangements and the number of movements of the signals make no distinction between the automatic signals worked by the new systems and those installed earlier.

Could not some American engineers give us fuller details about these new systems?

When did they begin to instal these new systems? What advantages do they possess over the old systems as regards original cost and maintenance, expenditure and more especially with reference to the actual regularity with which they work? It would be interesting to hear with reference to this last point something about the number of derangements which occur on lines where aerial transmission has been either completely abolished or at least markedly diminished.

**Mr. C. H. Platt, reporter.** — I infer the meaning of the question is as to the use of the track circuit as contrasted to the original track instrument and wire circuit, that is, the operation of the train over a track treadle or insulated section of the track, sending the current through a line wire to the battery controlling the signal at the further end of the block. If that is the question, I will say that that method of operation has been almost entirely done away with and is very much out of date. Almost universally in the operation of the automatic block signal system in this country, the energizing current is sent through the track, and the presence of a car, or a truck, or a bar of a workman, or a broken rail, would prevent sending that energizing current to clear the signal at the entrance of the block. That is almost the universal practice in automatic signalling. It is not, however, the practice in the manually controlled signalling, generally speaking, in this country.

**Mr. Brisse, French Eastern Railway.** — If you will allow me, Mr. Chairman, I will try to explain the question put before the section by Mr. Bleynie. Mr. Bleynie reported that the first time, in the experiments of their company, they used the air line, and I have read in the report of Mr. Platt that in America, in any new installations, the current is carried altogether in the rails. The important point of the question put by Mr. Bleynie is this, whether when the American railways had substituted the track circuit, the results were as good. Mr. Bleynie thought that in some way the results obtained in the experiments by his company were not so good, due to the fact that the open or air lines were influenced by atmospheric conditions, causing more failures than when the track circuit only was employed.

**Mr. C. H. Platt.** — There are perhaps more failures to clear a signal when the current is sent through the track than there would be if it were sent through an aerial wire, on account of the adverse conditions of insulation, but we have considered for a good many years that the automatic signalling should do more than record the fact whether or not a train was in a block, that if a train had broken in two and one car had been left in the block, or if there were a broken rail, or an open switch, or any occupation of the block, or any interruption to the working of the block, it should be impossible to clear the signal at the entrance of the block; and that result can only be accomplished by sending the energizing current to lower the signal through the rails; and while there may have been more failures, as I say, to clear the signal, the block clear and the signal not clear, the additional protection has been considered the paramount question, and it is almost universally adopted in this country.

Lieutenant-Colonel H. A. Yorke, Board of Trade, Great Britain. — Mr. Chairman, the two excellent papers we have heard read seem to me to summarize very completely the present condition of the question of automatic signalling. Of the two, the paper read by Mr. Platt appears to adhere more closely to the question which the Congress has to consider. That question is : *What are the recent improvements in automatic block signalling apparatus and what progress has been made in their introduction?* The question therefore does not invite a comparison between automatic and non-automatic signalling, although we have had some interesting information by the various speakers relating to the comparative safety and the comparative advantages of the two systems. The point to which I should like to draw attention is that there need be no difficulty whatever, for the Congress to arrive at a decision, as suggested by Mr. Platt, that automatic signalling, properly designed and installed, be recognized as a suitable means of protecting train and switching movements.

I take it there is no difficulty in accepting that conclusion, the importance of that conclusion being in the words, " properly designed and installed ". I also think that the second conclusion submitted by Mr. Platt is equally likely to be accepted : That any automatic signal system, effectually providing that the signals for any block cannot indicate safety before the last vehicle of the last train which may have been permitted to enter the block has cleared the same, be approved.

I imagine that we are all in accord upon both those general principles. But the whole importance, as I have already suggested, of those conclusions, lies in the words " properly designed and installed, " and in that respect I should like to suggest that a definite basis has not yet been laid down upon which to design automatic signalling. We have a great number of inventors and manufacturers, all introducing, or producing, appliances of great ingenuity and great merit, and each of them claiming to give some advantage which the other systems do not afford. But so far as I know, no railway company or no association of railway companies has yet laid down the broad principles which automatic signalling should comply with. Therefore, it has always seemed to me in studying this question, which I have done with a considerable amount of interest and care during the last few years, that more attention has been devoted to the mere mechanical details of the various apparatus than to the broad principles which automatic signalling is to serve.

In Mr. Margot's paper it is stated, at page 60 <sup>(1)</sup>, that the track circuit is the fundamental basis of most automatic block systems, and that it has the following properties : that " as long as there is an axle across the track inside a block-section where there is a track circuit, the signals controlling that section remain at danger. " I have always been an advocate of and believer in a track circuit, whether applied to automatic or to semi-automatic systems of signalling. It has always appealed to me as introducing, theoretically at any rate, the maximum of safety and the most

---

(1) Vide *Bulletin of the Railway Congress*, No. 12, December, 1904, p. 1630.

useful control over any movements of the signal, but I must confess that my faith has been rather rudely shaken in the last few weeks by the experience in England, which has shown that an axle, or even two axles, of one of our freight cars or wagons does not invariably place the signals to danger. It may be that the fault lies with our cars. Our cars in England have been criticized a good deal for various reasons, and perhaps this will afford a further reason for criticism. It may be in the construction of the wheels; it may be in the weight of the car, but whatever the causes may be, which, as far as I understand, have not yet been ascertained, the fact remains that a single vehicle, unloaded, does not invariably place the signals behind it to danger. It does so generally, but it does not do so invariably; and that has been causing us, and me personally, a considerable amount of anxiety, and a careful investigation is now being made in England to ascertain the cause of this occasional failure. I have no doubt the designers of the various systems or signalling will be able to overcome the difficulty in time, but I think it right to mention the fact, because it is stated here definitely that where there is a track circuit, the presence of a single axle across the track will place the signal at danger, whereas with our goods wagons in England that can hardly be said to be the case.

**Mr. Th. Voorhees.** — Mr. Chairman, I would like to suggest that Colonel Yorke's criticism is against the installation and not against the principle. I have known signals to go at danger because of the fact of a goat tethered with a chain walking across the track, the chain resting on the two rails and setting the signals to danger, but if we have a section car with one wooden wheel and put that on the track, we do not get any indication at all, because we have no means of carrying the current. You must give us a chance for the current to pass through the vehicle, from one rail to the other, or else you get no connection.

**The President.** — The discussion seems to be at an end. I have just noted down here what I think may represent the feeling of the section generally on this matter. Any resolution read in this way is only provisional, but I have noted the following:

“ The Congress notes that there has been very great improvement and extension of automatic signalling since its last session and that those who have used it have found it effective for their purpose and that the promises made on behalf of the system have been fulfilled; that the failures are not numerous and are lessening every day.

“ The Congress is not, however, prepared to recommend that its general adoption supersede present systems of non-automatic working, though there are many cases of heavy and increasing traffic where it may have special advantages”.

**Sir Charles J. Owens.** — May I suggest, Mr. Chairman, that in mentioning failures, which you very properly say are not numerous, you might state that the failures have been in the direction of safety. The failures which occur which would lead to danger are extremely few, and I should be sorry to make a record about it which would suggest that there is any appreciable proportion of failures which would

be in the direction of danger. In connection with what has been stated, I would modify it to this extent. "That the failures are not numerous and in few cases lead to any danger, and are lessening every day".

**Mr. C. H. Platt, reporter.** — Mr. Chairman and Gentlemen. The object that I had in preparing the report, giving you so many statistics, was to meet exactly the conclusions made at the Paris Congress, which read :

*In respect to the absolute automatic block*, intended to dispense with human labour, the Congress, while appreciating the theoretical advantages which may arise from the use of the insulated track in order to meet the requirements named above, considers that it would be premature to formulate a definite opinion without knowing, on the one hand, the results of continued trial of longer duration of these systems made on main lines by European managements, and on the other hand the influence which insulation of the track may have on strength of construction of the permanent way, on the requirements of maintenance, on possibility of rapidly replacing rails, etc.

The last item, "the influence which insulation of the track may have on strength of construction of the permanent way," has been found to be nil. There is absolutely no interference with the integrity of the permanent way by the use of the track circuit; and the only other question, taking this conclusion as a basis, is as to whether there has been a sufficient experience with the automatic block-system to have it favorably recognized by this Congress. Hence I went to a great deal of trouble and spent a great deal of time in gathering statistics to show just what experience we have had with automatic signalling in this country. It is not perhaps wise from the standpoint of the Congress to go into very definite and far reaching conclusions, but the Congress has enunciated its past conclusions and has practically "thrown down" the automatic signal system, saying that its use was not warranted. I refer perhaps to the one adopted at St. Petersburg, which reads as follows :

With respect to apparatus which are entirely automatic, it is the opinion of the Congress that, under present circumstances, it would not be possible to rely on their working for ensuring safety.

Now, that is against the automatic signal system. The subsequent action of the Congress has been non-committal, the last one asking for further experience. We have reached a position in this country where we have 20,000 signals in operation, protecting over 10,000 miles of track and making more than 405 million of movements per year, and we submit that that has been sufficient experience for this Congress to take some action to qualify the unfavorable action that has been taken heretofore. Now, we do not claim, at least I do not, and I think no friend of automatic signalling claims for a moment that it is the only system of signalling. We admit that there are very many cases where the manually controlled signal is much better. We do not ask for a moment that automatic signalling be substituted for the manually controlled signalling system. We simply say that we are using it effec-

tively, economically and satisfactorily, and we feel that we have arrived at a point where there should be some positive recognition of automatic signalling in the conclusions to be reached by this Congress.

I am entirely in accord with the conclusions proposed by the President so far as they go, but I would like earnestly to ask that the conclusions, as read by Colonel Yorke, be added, in order that the automatic system may be placed on the same basis in the eyes of the public as the manually controlled systems. I do not care to discuss the comparison. There are cases where the presence of a man at the signal box is useful and where it may be entirely necessary that he should be there, where it is economy to have him there, and in those cases we say, "Certainly, put in the manually controlled signal and have the man, have him watch your trains, have him perform all the other functions," but that is outside of the signal system in itself. The signal system is for the protection of trains; and if you desire to go into the comparisons, we find that men in these signal boxes do not always do their duty. They sometimes get intoxicated, sometimes have a fit, sometimes are called away temporarily; but in the automatic signal system the power that protects your trains is on duty night and day, it never gets drunk, it never has a fit, it is never absent from duty, it is reliable all the time. If we should follow out the replies to the various points that have been made, it would take a long time and would be disconnected, on account of the various phases of the discussion, but I do want to request that either the conclusions found in the report, or similar ones, recognizing this signal system as worthy of adoption by this Congress, be added to the conclusions.

**The President.** — I will read this provisional resolution once more, and I am sure that I think it is as far as the section is justified in being recorded. I may plead that though I am presiding over you here, I am one who is perfectly unfamiliar with the technical details of these matters, and therefore I do hesitate, more perhaps than another would, to put on paper what I do not myself fully understand; but I think that Mr. Platt may be satisfied with the decided progress and friendliness, I should say, of this resolution by the side what was passed at the Congress in Paris.

(The President read again the resolution previously proposed, modified by the insertion after the words, "that the failures are not numerous" of the words "and in few cases leading to any danger".)

**Mr. Th. Voorhees.** — Mr. Chairman, why say anything about the failures? because I know in my experience that there are quite as many failures, and quite as disastrous failures, from the manually controlled blocking, or from absolute blocking, as you will get from any automatic blocking that has been used for the last ten years. Why mention the failures?

**Mr. Evelyn Cecil, M. P., London & South-Western Railway.** — Mr. Chairman, I want to plead that the conclusions of Mr. Platt's paper, which have been read by Colonel

Yorke and others, should be added to the resolution. I do not think that it is going at all too far. I feel that after the discussion we have had to day it is perfectly plain that automatic signalling has made very great strides since the last session of the Railway Congress, and that if we do not adopt some such addition to the proposed resolutions, this section will be rather showing itself behind the times and not up to date with the progress of automatic signalling. I am anxious to press as earnestly as I can that this consideration should be borne in mind and that we should add Mr. Platt's conclusions to the general resolution which has been proposed. (*Applause.*)

**Lieutenant-Colonel H. A. Yorke.** — Mr. Chairman, may I be permitted to support the plea of Mr. Cecil that some form of recognition should be given to automatic signalling in the resolution that is put before this meeting? We in England have several cases of installation of automatic signalling which have received official approval, and I should be glad at any rate if that official approval were endorsed by such an important as this Congress is.

**The President.** — There are two amendments, really, to the wording which I have suggested. The first is that all allusion to the failures should be omitted, and that it should read in this way :

“ The Congress notes that there has been much improvement and extension of automatic signalling since the last Congress, and that those who have used it have found it effective for their purpose,” and then go on to say that “ The Congress is not prepared to recommend automatic block signalling for general adoption to supersede existing systems, but they consider there are cases of heavy and increasing traffic where this system may present special advantages.”

That is one amendment and I will ask those in favor of leaving out all mention of failures, as nothing has been said about the failures of non-automatic signalling, to hold up their hands. . Remember that this is a provisional resolution which must be approved by the General Secretary before it is submitted in the morning.

— Carried.

**The President.** — The other suggestion is that the two conclusions of Mr. Platt's report should be incorporated in our resolution.

**Mr. Mange,** Orleans Railway, France. (In French.) — I do not well see how the conclusions can be accepted in the shape proposed by Mr. Platt. The first appears to me to be a replica of the first paragraph of the conclusions proposed by the section's officials and this already affirms the progress effected by the automatic block-system since last session. As for the second of the conclusions suggested by Mr. Platt, it seems to me liable to be interpreted in a manner that would — I fancy — go beyond our meaning, in so far as it states any block-system is to be recommended, provided it possesses certain arrangements. It would seem better to adopt some

wording bearing a less general meaning and state for instance : “ For companies which find themselves in a position to adopt automatic signalling, a system is to be recommended which provides that the signals controlling a section cannot show “ line clear ” before the last vehicle of the last train which has been authorized to enter this section has left it. ”

**The President.** — I think what Mr. Mange has suggested really is the same thing as the original.

**Mr. Mange.** — It is not the same thing if you look at the French translation of Mr. Platt's conclusions. Perhaps in the original English text it is otherwise.

**The President.** — Practically the same, it seems to me.

**Mr. Piéron, French Northern Railway.** (In French.) — I propose that we add No. 4 of the conclusions submitted by Mr. Margot :

*Regarding the working of the automatic block :*

On lines already equipped with the non-automatic block there is generally no advantage in incurring the expense of the change, at any rate under those conditions which apply to the working of lines outside the United States of America.

In the case of lines not yet equipped with a block-system, it may be found that the automatic block can be adopted with advantage, according to the particular conditions, the service to be organised and the economy of staff to be effected as compared with the non-automatic block.

— This proposal was not carried.

**The President.** — The conclusions to be submitted to the general meeting will then provisionally run as follows :

“ That automatic signalling properly designed and installed be recognized as a suitable means of protecting train and switching movements.

“ The Congress notes that there has been much improvement and extension of automatic signalling since the last session, and that those who have used it have found it effective for their purpose.

“ The Congress is not prepared to recommend automatic block-signalling for general adoption to supersede existing systems, but they consider there are cases of heavy and increasing traffic where this system may present special advantages. ”

— Carried.

— The meeting rose at 12.35.

# DISCUSSION AT THE GENERAL MEETING

---

**Meeting held on May 11, 1905 (afternoon).**

---

**MR. STUYVESANT FISH, PRESIDENT, IN THE CHAIR.**

**GENERAL SECRETARY : MR. L. WEISSENBRUCH.**

**ASSOCIATE GENERAL SECRETARY : MR. W. F. ALLEN.**

**Mr. H. Tylston Hodgson, president of the 3<sup>rd</sup> section, read the**

## **Report of the 3<sup>rd</sup> section.**

(See the *Daily Journal of the session*, No. 7, p. 133.)

“ Mr. C. H. PLATT, having been invited to sum up his report, explained that it was not intended to institute a comparison between the different types of signals, the questions submitted to the Congress being the following :

- “ 1° What are the latest improvements in automatic signals?
- “ 2° What progress has been made in their introduction?

“ The facts stated in the first part of the report, are based on the information given by the different companies manufacturing automatic apparatus <sup>(1)</sup>. The second part contains the statistics furnished by the railroad companies using the apparatus, and shows the progressive development of their use and the results obtained. The last part of the report contains the conclusions submitted to the Congress for approval.

“ Mr. C. H. Platt thought that these conclusions should be adopted because the reports hitherto made on the question of the automatic block system have been either unfavorable or non-committal.

“ The automatic system has now come into sufficiently general use to leave no doubt of its efficiency,

“ The question whether an automatic or a manually controlled system should be

---

(1) Numerous innovations have been brought to the attention of the reporter. He has taken notice of those only which have proved their practical value during some length of time.

adopted on a given line or under given circumstances, is not subject to examination. The decision to adopt one or the other of these systems in special cases, should be left to the judgment of the companies interested. But the automatic system has reached such a high degree of perfection, that it may be considered as a safe and economic method of protecting trains on railways, and, with this in view, it should receive the approval of the Congress, which is the highest authority in railway matters.

“ During the year 1904, notable progress has been made. While the number of movements made on the total of the lines furnished with the automatic system, increased 144 per cent, the number of failures, consisting of indicating “ danger ” when the line was “ clear ” increased 32 per cent only. On the other hand, the number of more serious failures, indicating “ track clear ” when the track was really occupied decreased by 30 per cent.

“ These results were observed in the working of all signals, on those in service for thirty years, as well as on those more recently installed.

“ The PRESIDENT then called on Mr. Margot, traffic superintendent of the Paris Lyons & Mediterranean Railway, to sum up his report.

“ Mr. MARGOT explained that in Europe the automatic block system has remained practically without progress, because it had been in operation upon only five sections of lines, representing a total of 119 kilometres (74 miles) or about  $\frac{3}{1000}$  of the total lines operated by the block system. During this time the American railroads had proceeded on a large scale towards automatic signalling.

“ The reporter had been interested to look for the cause of this state of affairs, which has led him to take up the whole question of the automatic block system and to make a comparative study of the conditions of operation with a block system which has long been in use on the European roads, and he has thus been led to the following conclusions :

“ The automatic block system appears to be a perfect theoretical solution when a track circuit is used. The track circuit accomplishes in the most complete way the spacing of trains on the same line. It solves in a very simple way special cases of tracks occupied and those arising from breaking of couplings. It allows the signal to exercise a permanent control over the condition of the track. Finally, by its automatic action it avoids errors due to the human element, and the absence of the signalman is without consequence if everything goes on in its normal way.

“ But in practice, account should be taken of the possible failures of the apparatus, and in this respect the automatic systems tried in France have not yet attained that degree of perfection which should be required, even more from the automatic system than from those which are not automatic. It should also be remembered that accidents are unavoidable in the running of trains, and that the presence of men stationed on a line enhance the degree of safety, especially on a very busy line.

“ The automatic block system does not furnish the same guarantee, except at stations where there is an agent engaged in watching the movement of trains and intervening in the case of accidents, so that the automatic block system does not always result in those economies in the signal staff which is really its object. This is a question of local conditions.

“ With this in view, the reporter referred to the answer obtained by him from the Belgian State Railways, on which 1,633 kilometres (1,015 miles) of the Siemens block system are installed.

“ The Belgian State Railways have experimented with the Hall system and have given it up for the following reasons :

“ 1° No economy in staff is possible when the line has many stations or many grade crossings;

“ 2° Unavoidable failures in the apparatus should be taken into account, as in these cases, the intervention of the employees is most useful.

“ In short, there is no special advantage in introducing the automatic system on lines which are already provided with a good working system, but on new lines it may be advantageous.

“ The reporter, therefore, proposed the following conclusions :

“ 1° On lines already equipped with non-automatic systems working well and giving full satisfaction, it is frequently of no advantage to substitute the automatic block system in their place at a great expense, or at any rate under those conditions which apply to the working of lines outside the United States of America;

“ 2° On lines not yet equipped with the block system it may be found that the automatic block can be adopted with advantage, according to the particular conditions, the service to be organized and the economy of staff to be effected. ”

“ Mr. RICHÉ (*French Eastern Railway*) wished to read the remarks of Mr. Piéron, chief engineer of the out-door traffic department of the French Northern Railways, who was detained in another section and was therefore unable to offer them in person.

“ Mr. Piéron thought that the interlocking block system in use on the French Northern Railways gives as great safety as possible, in that it avoids, to a large extent, the possibility of human error.

“ The substitution for the present system of the automatic block system, will involve considerable expense in installation, which would in no way be justified by the object to be obtained, in view of the fact that the results already attained are very satisfactory.

“ To the remarks of Mr. Piéron, Mr. Riché added, in the name of the Eastern Railway of France, the following remarks :

“ The question treated can be summed up thus : What is the ratio between human error and the failure of apparatus?

“ It seems certain that when the traffic of a line increases in large proportions, one cannot count indefinitely on human infallibility, and that the guarantee of safety thus decreases. It would seem that this reduction in the element of safety, would be less with automatic apparatus. In other words, it appeared to him that the running of trains on a line can be more readily increased without reducing the safety, with automatic apparatus than with apparatus controlled by men.

“ Mr. Riché held the opinion that under such conditions, it is proper to take the future into account, and he concurred with the very broad conclusions of Mr. Margot, who leaves to each company full liberty of action. He concluded by asking the representatives of American railroads, whether they still have lines not equipped with automatic apparatus and, if so, whether they intend so to equip them.

“ Mr. Theodore VOORHEES (*Philadelphia & Reading Railway*) reported to the section that he had installed the block system on the New York Central & Hudson River Railroad lines some fifteen years ago; 102 cabins were constructed on 142 miles, the system installed having been copied from the English system (Saxby & Farmer); soon, however, the traffic became too dense and it became necessary to use the system permissively instead of absolutely.

“ About ten years ago, the Hall system was introduced on the Philadelphia & Reading lines; a few cases of false indications occurred, the majority of which were due to lightning fusing the points of the relay. These defects were soon eliminated. The number of false indications, even during the months when storms are most frequent, was soon reduced to a maximum of three or four. On all parts of his system where the traffic is dense, that is, on about 400 miles of the 1,400 in operation, this system is in use, and the complete replacing of hand signals is only a matter of time. By the installation of distance signals placed at a distance sufficiently ahead of the ordinary signals, the Philadelphia & Reading Railway has avoided the difficulties resulting from a driver passing a signal erroneously and entering on the following block.

“ Sir Charles OWENS (*London & South Western Railway, England*) stated that a point which has not yet been mentioned, and which is of great importance, consists in the installation of a mechanical means to operate even non-automatic signals. By such an installation his company has succeeded in reducing, to a large extent, the number of men necessary at its stations. When the installation of the necessary operating power has once been made, the introduction of the automatic system within the distance controlled by it is easily made. On the London & South Western road, the mechanical system generally controls 6 miles each side of the power station. The absolute block system is in force on all the lines of the company, and it suits the requirements of a light traffic perfectly, but when the traffic gets heavy, an automatic system is much more advantageous. No false indications with the exception of those indicating “ danger ” when the road is really clear, have occurred on the lines of his company.

“ Since the introduction of corridor cars, it is no longer necessary to have employees along the line to watch the trains, for the train hands can see all that is going on. An innovation introduced on the London & South Western Railway, consists in installing a telephone station at the base of every semaphore signal, which permits the train conductor, as soon as the train stops, to ascertain the cause of the detention.

“ Mr. Theodore VOORHEES informed the section that the terminal station of the Philadelphia & Reading at Philadelphia, where the daily movement of trains is about 500, inbound and outbound together, is protected by the Westinghouse interlocking system. The signals are installed for distances of as much as 1 mile from the station itself.

“ On the Philadelphia & Atlantic City division, where the traffic is very heavy, and the length is 55  $\frac{1}{2}$  miles, there are only three interlocking cabins; the rest of the line is protected by the automatic system.

“ Mr. G. BLEYNIE (*French Midi Railway*) said that the Hall system has been put in operation on some parts of the lines of his company, but it has shown quite a number of failures, especially by signalling “ danger ” when the track was really clear. The proportion of failures has been about 3 per 10,000 movements, which is a much higher figure than that given by Mr. C. H. Platt for American practice. Many of these failures have been caused by the crossing of the overhead wires necessary for forming the circuits.

“ Mr. Bleyne asked the American engineers if they can furnish data as to the number of failures on lines where overhead transmissions have been either entirely abandoned or largely reduced in number. Does this reduction or abandonment give good results, and does it produce saving in the electric current necessary to operate the apparatus?

“ Mr. C. H. PLATT, reporter, replied that he could not furnish any figures, as lines using overhead wires have been practically abandoned. The system most in favor in America at present is track circuit, by which the energizing current is transmitted through the rail. This system perhaps causes more failures — *i. e.*, signals of “ track occupied ” when the track is clear — but it has the great advantage of signalling not only the presence of a train in a certain block, but also a number of other accidents which may occur, such as the presence of a truck, a broken rail, open switch, etc.

“ Lieutenant-Colonel H. A. YORKE (*British Government*) was of the opinion that the report presented by Mr. C. H. Platt adhered more closely than that of Mr. Margot to the question which the Congress has to consider, — *viz.*, what the recent improvements are in automatic block signalling apparatus. According to him, any comparison between a hand signalling system and the different automatic systems should be excluded as irrelevant. He thought that the Congress should accept the

conclusions presented by Mr. C. H. Platt. He noted, however, not only that different companies do not agree as to the superiority of any one automatic system over other systems recommended, but they have never expressed themselves positively upon the general principles which should govern automatic signalling. He has always been a strong advocate of track circuits, but he has observed, at least in English practice, that some cars with two axles do not invariably complete the circuit and consequently do not operate the signals. This has greatly shaken his faith in the efficiency of automatic systems depending on a track circuit.

“ Mr. Theodore Voorhees replied that to operate the signals it is necessary to complete the circuit and therefore if the construction of the wheels or axles does not admit of this, the signals cannot give the indications which they are intended to transmit.

“ Mr. C. H. Platt desired to call the attention of the assembly to the statistics contained in his report, which were compiled to meet the conclusion framed by the Congress of 1900 and to show the progress made with automatic signals since their adoption on a large scale. The results obtained in practice are shown by the great number of signals now in use, there being now over 20,000 in the United States, protecting 10,000 miles of track. These have made more than 405 million's movements in the past year. He urged that the Congress should adopt the conclusions in his report.

“ The PRESIDENT presented the conclusions and after a long discussion in which many of the members of the section took part, they were approved in the following terms. ”

**The President.** — The following are the

#### CONCLUSIONS.

“ That automatic signalling properly designed and installed be recognized as a suitable means of protecting train and switching movements.

“ The Congress notes that there has been much improvement and extension of automatic signalling since the last Congress, and that those who have used it have found it effective for their purpose.

“ The Congress is not prepared to recommend automatic block signalling for general adoption to supersede existing systems, but they consider there are cases “ [[of heavy and increasing traffic]] (1) where this system may present special “ advantages. ”

---

(1) The words within double brackets were struck out in the accepted text (*vide* the decision below).

**Mr. H. Tylston Hodgson**, *president of the 3<sup>rd</sup> section*. — I have been asked to leave out the words “ of heavy and increasing traffic ”. The absence of these words would in no way alter the general idea of the conclusions, as they affect most instances and countries, but still to strike out this phrase would be some advantage where a wrong construction may be placed upon the conclusions as applying to some countries.

**Mr. von Leber**, Austrian Imperial & Royal Ministry of Railways (in French). — I second the suggested amendment because I think the wording is made more clear by striking out these words.

**The President** put to the vote the conclusions as amended by striking out these few words.

— Carried.

# APPENDIX

---

## Supplement to report No. 1

By C. H. PLATT,

EX-GENERAL SUPERINTENDENT WESTERN DISTRICT, NEW YORK, NEW HAVEN & HARTFORD RAILROAD.

---

Figs. 23 to 29, p. 1580 to 1585.

---

Report No. 1 closed on September 1, 1903, since which time many improvements have been made in automatic block signaling apparatus, this comprising the first sub-division of the question considered in this report. Many of these improvements are as yet experimental and have not been subjected to conclusive tests in actual operation and cannot, therefore, have more than a passing reference at this time.

The following improvements, however, have successfully passed the experimental stage and are briefly described :

### **Harrington electro-hydraulic automatic signal.**

This system, first installed in actual operation in October last on a line having an average of 650 train movements per day, includes several new features in automatic signaling :

- 1° The use of a hydraulic accumulator;
- 2° The use of a pump operated by an electric motor or other power to charge the accumulator;
- 3° A new arrangement of circuits for signal control for electric lines where the running rails are used for the return power current;
- 4° An arrangement of parts through which the semaphore arm assumes an intermediate position between the danger and clear indications, when from any cause the signals or their connections are not in working order;
- 5° An illuminated semaphore arm giving a position night signal.

The pump, run either by direct mechanical power, supplied through the action of the trucks of passing trains, or as at present installed at the Washington Railway Exhibition, by a motor operated by an electric current from the third rail or feeder line of an electric road, supplies the accumulator with fifty or any prearranged number of signal movements. When the limit is reached, the power is cut off automatically. The power for operating the semaphore arm is a nonfreezing liquid in the accumulator acting under pressure. When in the operation of the system, say forty-five signal movements have been made, the pump starts automatically and again supplies the accumulator to the limit, as before. If from any cause, such as failure of power, disarranged or broken circuits, etc., the accumulated movements run out by the ordinary operation of the signal, the signal-necessarily and automatically assumes the intermediate position, obviating the necessity of any train passing a signal in the danger position, also obviating the necessity of stopping at signals not in working order, the position of the semaphore arm being a notice of the fact and indicating caution as well.

The signal control circuits provide for holding the signal at danger, not only until a train reaches the insulated rail, but until the entire train has passed beyond it. The length of such insulated rails to be so that at least one truck is on the section until the last car has entirely cleared, this taking the place of the ordinary track circuit to that extent, the circuit for the return power current through the running rails being maintained by means of a cable conductor passing around the insulated section.

The semaphore arm is of the inverted U shape. The two parallel sides of the usual semaphore type, permanently closed on the top edge, closed on the bottom edge by a swinging part with an automatic catch. The space between the two parallel sides used for a line of incandescent lamps, suspended over roundels of colored mica, one each for the danger and the clear indication for each lamp. Arms in horizontal position, lamps suspended behind red roundels. Arms lowered for clear indication, lamps swing to positions between roundels colored to give that indication. All to cover the general arrangement of giving a position as well as a color signal at night. The lamps are automatically extinguished when signal is not in working order.

The details of this system further include :

- a) A semaphore post having an enclosed space at the top in which the working connections of the semaphore arm are placed. The usual seven day oil lamp not only illuminates the semaphore lens, but protects the working parts from frost;
- b) A folding ladder inside the post box, handy for use when required, but not available for mischief-makers;
- c) Interchangeable and reversible parts so that any one post or set of fittings can be used for a two arm signal or for a single arm signal for train movements in either direction.

Automatic appliances for setting power brakes, should a train pass a signal giving the danger indication, are many; mostly in the experimental stage, and as a rule do not operate on the normally danger principle. During the past year, however, the Kinsman system, in a somewhat modified form, has been installed on the express tracks of the New York underground lines as supplemental to the automatic visual signals. The successful operation of this system on so important a line for several months warrants its consideration as having passed the experimental stage.

The following is a brief description with cuts :

#### **Kinsman block system company.**

The apparatus used by this company is designed to automatically control the power and brake connections on steam or electric trains in cases of emergency or when enginemen or motormen fail to regard danger signals. The controlling points are placed just beyond the home signals. There are various form of devices, but that which has given the best results consists of the following : Wire circuits are looped into or controlled by the battery circuits of the various visual signal systems. These circuits are continued to and include contact rails of a very substantial character, placed between the main running rails, and raised one or two inches above them. Great care has been exercised in producing of form a contact which will meet the demands of high speed traffic.

The contact rail may be either continuous or sectional. Where a constant contact is required, a continuous rail is used. This results in a complete closed (normally danger) circuit for the engine apparatus and road circuits. Where sectional contact rails only are used, the result is an open circuit, as between the engine circuits and the contact rail circuits between sections, but this system is designed for use as an auxiliary to the visual signals, and in no way lessens their efficiency, and in the latter case, as the road circuits are normally closed and so arranged that any defect therein results in the semaphore taking or holding the danger position, the objection to the intermittently open circuit is largely eliminated.

Figure 23 represents locomotive equipment in normal running position, throttle valve open.

Figure 24 represents locomotive equipment after the power has been automatically cut off and the air brake set.

In both figures 23 and 24 are shown the balanced throttle valve B with bell crank and throttle stem attached to a cylindrical follower within cylinder C. This follower contains four 200-pound clutches *h*, any two of which holds against any movement of the throttle lever A by the engine driver, the result being that the follower or piston travels with throttle stem BA' in any position it may be placed for taking steam, but always covering port *k* when steam is being used. It follows that the introduction of the air pressure from train pipe F', resulting from the action of magnet M, through chronometer valve V exerts sufficient pressure on follower H

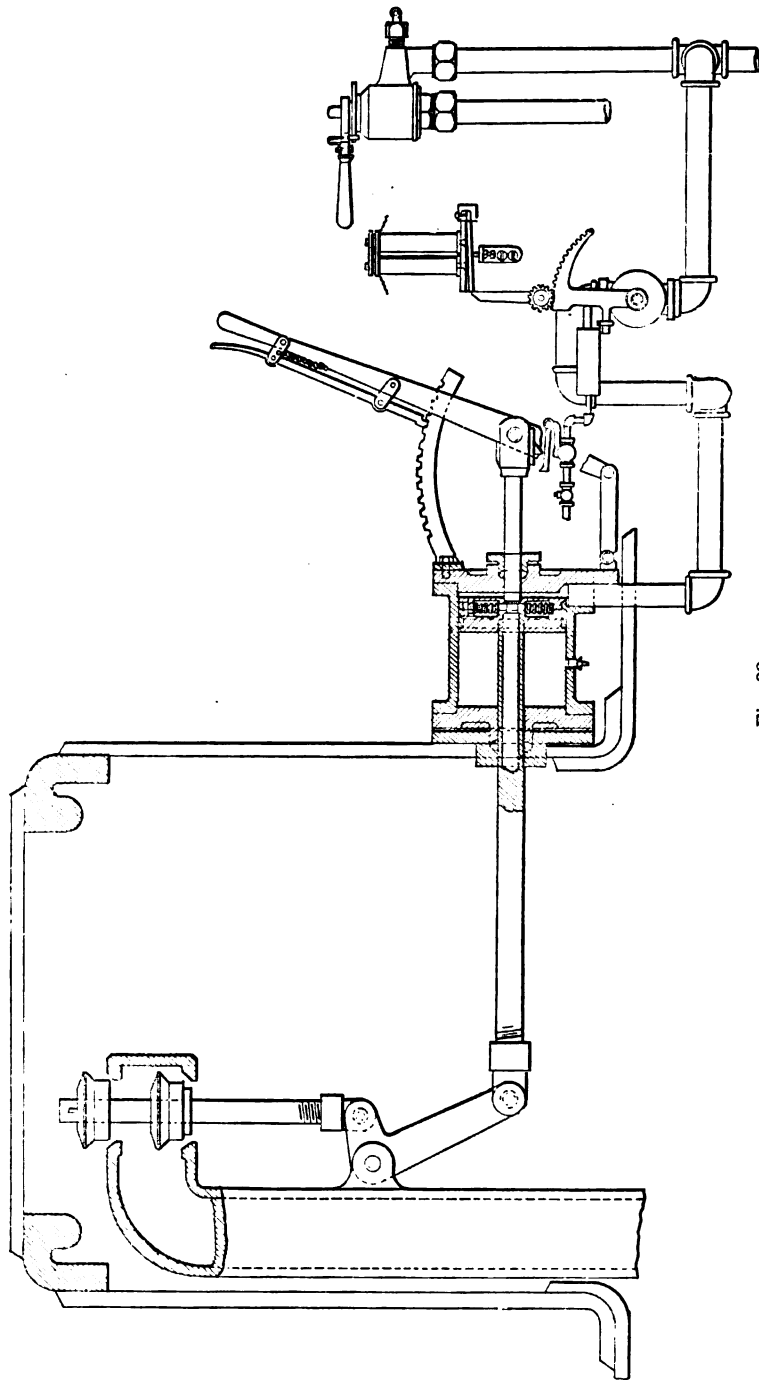


Fig. 23.

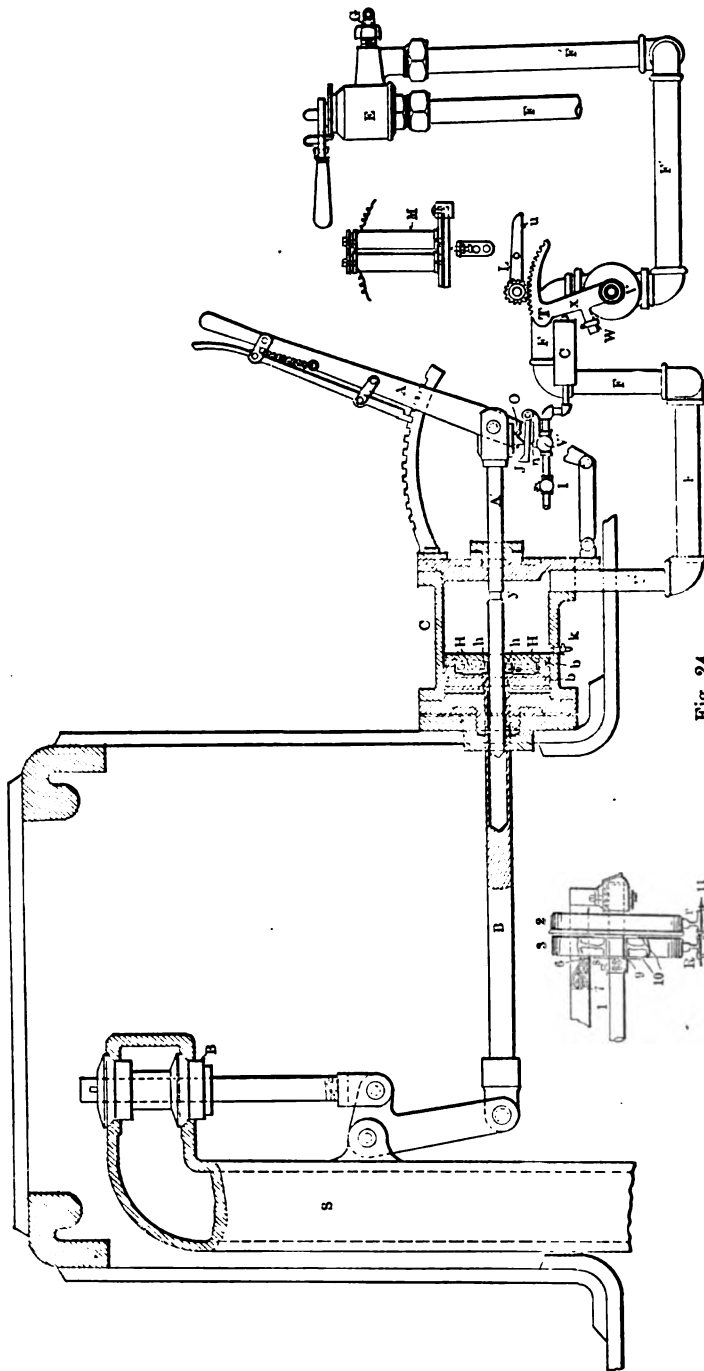


Fig. 24.

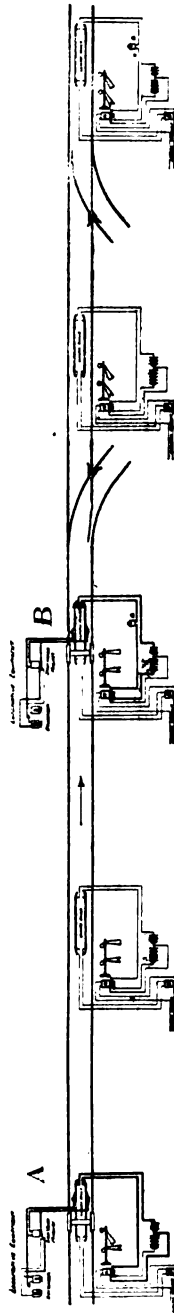


Fig. 25.

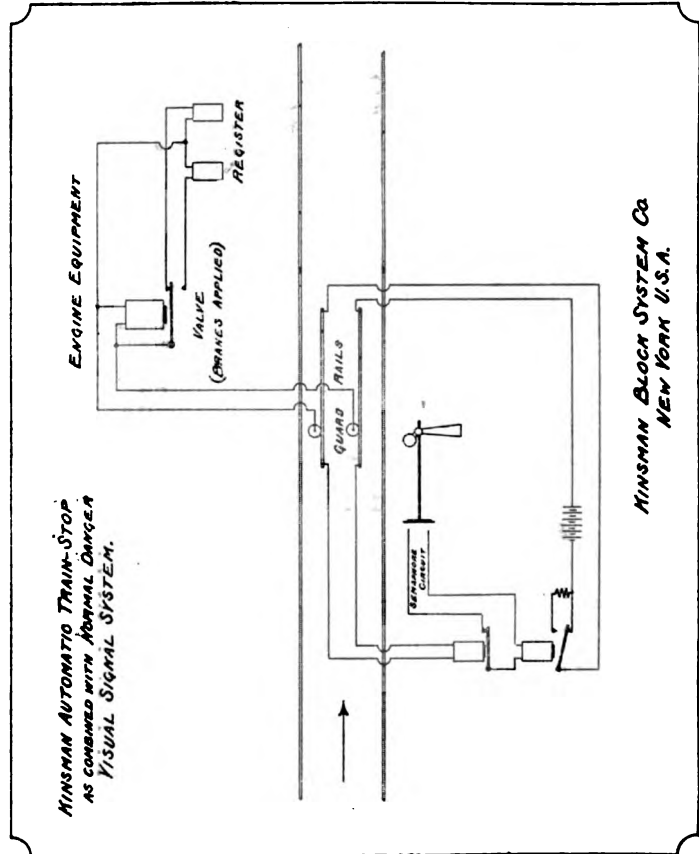


Fig. 26.

to cause its clutches *hh hh* to ride up the slightly bevelled side of depression *Y* to a point which uncovers port *k*, in which position throttle valve *B* is closed, as though it had been done by the engineer with the forward movement of throttle lever *A*. The air then escapes through port *k*, and the air brakes are set in a manner similar

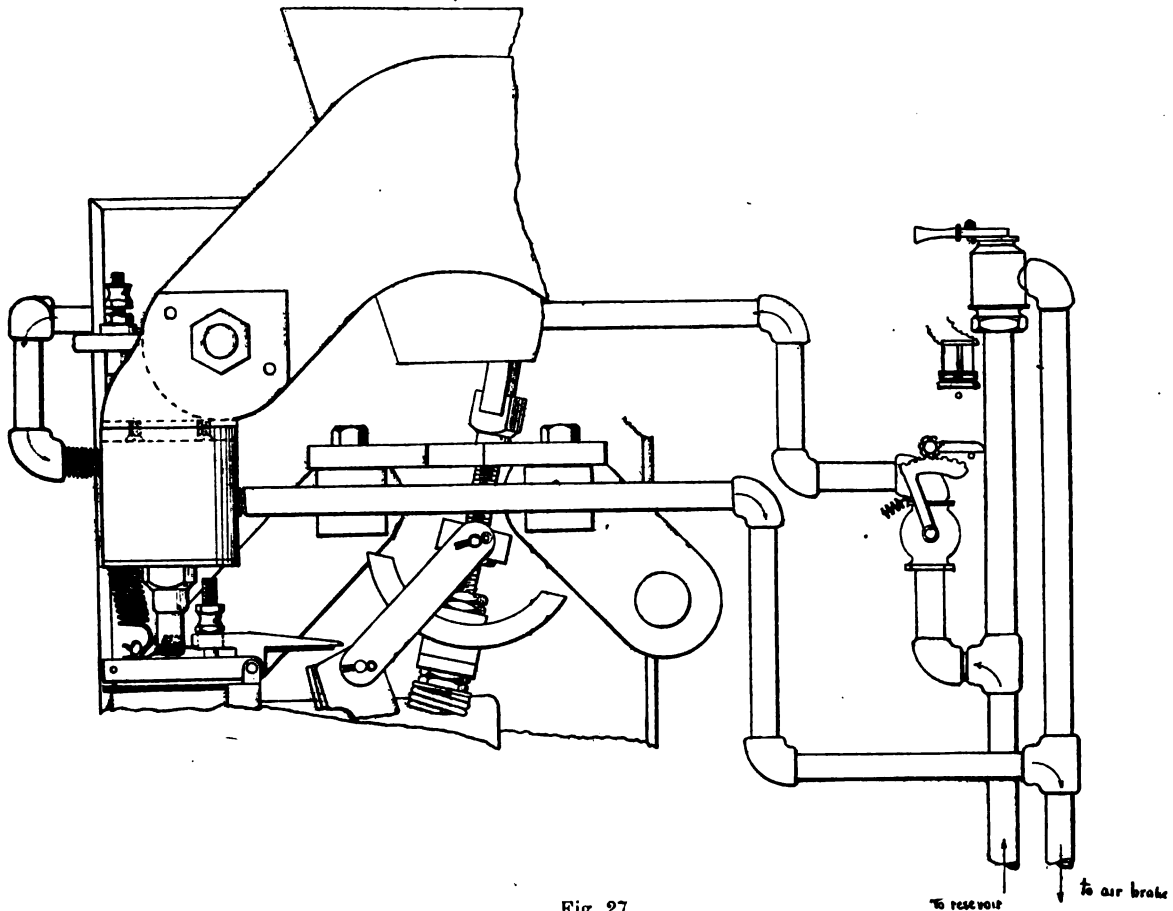


Fig. 27.

to the operation of the engineer's brake valve *E* by hand, thereby bringing the train to a standstill in the absence of the engineer or any counteracting effort on his part. When he is ready to proceed, he throws forward throttle lever *A* as in the act of shutting off the steam by hand, thereby bringing depression *Y* into position for the re-engagement of clutch *k*, which act opens valve *V'*, introducing air pressure into small cylinder *C*, which automatically resets chronometer valve *V*, thus admitting of the restoration of the pressure in train pipe *F'* and otherwise restoring normal

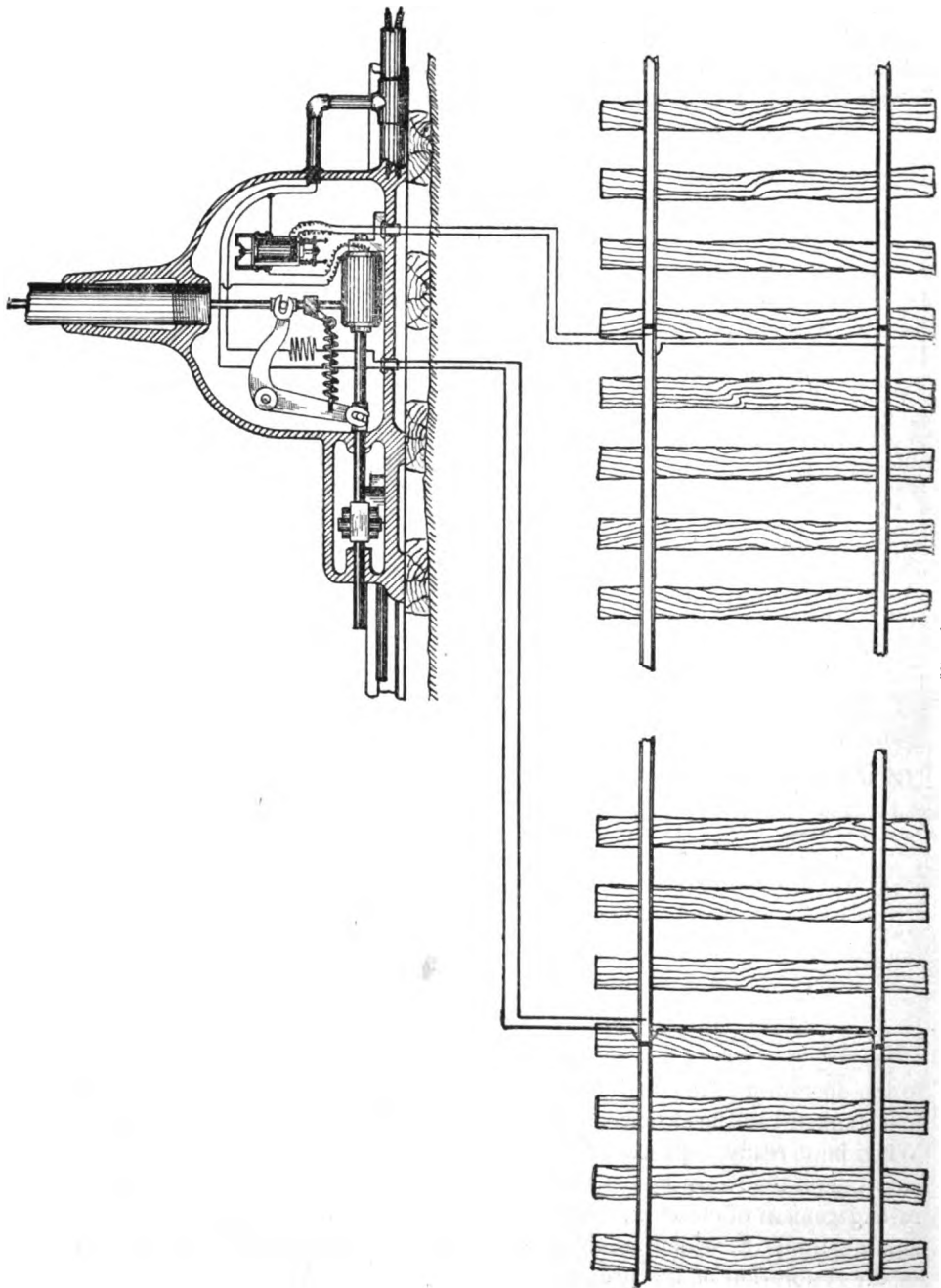


Fig. 28.

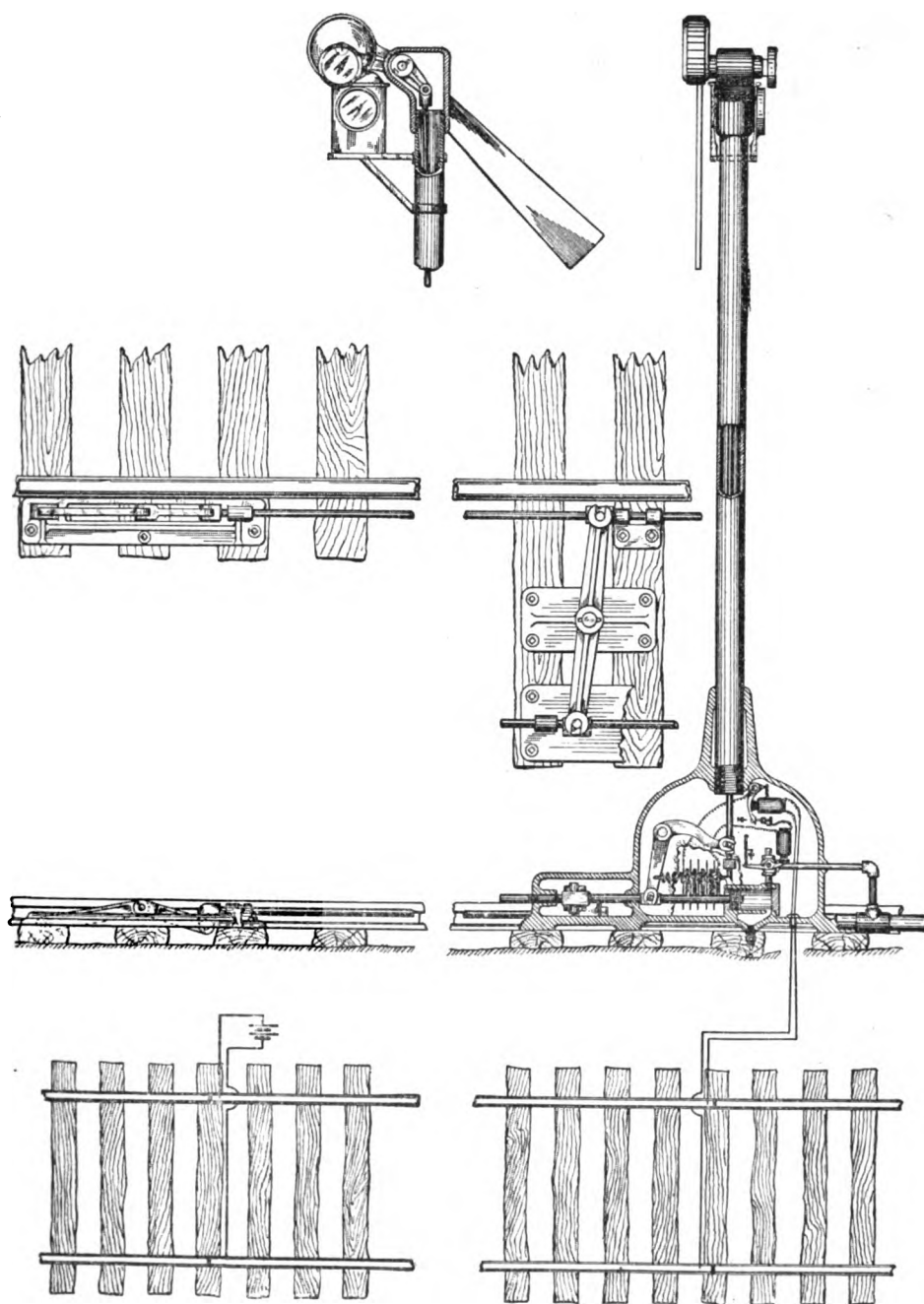


Fig. 29.

running conditions. It will be seen that all automatic movements are in the direction of safety conditions. Port *k* is adjustable to service or emergency stops, and is subject to modification in case of vacuum brake equipments.

Figure 25 represents a modified form of automatic control circuits in combination with normal safety visual indications.

Figure 26 represents a normal danger automatic control system, in which circuit defects cause a danger indication by the symaphores during the continuance of a broken circuit in either.

Figure 27 illustrates one form of electric motive power and air brake control for use with or without visual signals.

Figure 28 represents electric control apparatus using current from the power circuit.

Figure 29 shows the automatic tripping device, especially designed for elevated or underground lines.

#### **Union Switch and signal company.**

The track circuit control of automatic signals for electric lines using alternating current for the signal system, as heretofore installed by this company, has required the use of one rail for the control circuit. An improvement recently worked out is a system in which both rails are left available for the direct power current and an alternating current is used on the same rails for the control circuit. At each end of each block section is inserted an impedance bond, which permits the free passage of the power current, but does not permit the passage of the alternating signal control current. The apparatus has already been installed on one line, and is in successfull operation. Other more important installations are now in progress.

---

The use of storage batteries for the operation and control of various types of automatic signals, while not new, has received much attention and favorable consideration during the past year. By the use of such batteries, a higher efficiency in signal operations is obtained as compared with the use of primary batteries, and where the conditions are suitable, they are found to be economical as well as more efficient. Experience so far indicates that under such conditions the saving is about thirty per cent per year on the cost.

---

SUB-DIVISION B.

What progress has been made in introduction of signals?

The following statistics cover the signal operations in the territory covered by this report for the year 1904.

The statistics as to the number of automatic signals installed or under contract is to April 1, 1905.

Table I.

*Number of block signals April 1, 1905.*

SIGNALS.	Number September 1, 1903.	Number reported since that date.	Total.
Electro-pneumatic semaphore . . . . .	3,100	2,900	6,000
Electric semaphore . . . . .	4,049	2,864	6,933
Electro-gas semaphore . . . . .	495	1,439	1,934
Enclosed disc . . . . .	4,485	212	4,697
Clockwork disc . . . . .	1,090	75	1,165
Total. . . . .	13,219	7,510	20,729

Table II.

*Number of signal movements.*

Number of roads.	SIGNALS.	Average per day, 24 hours.	Average per month, 30 <sup>5</sup> / <sub>12</sub> days.	Total for year.
6	Electro-pneumatic semaphore . . . . .	241,132	7,334,423	88,013,073
17	Electric semaphore. . . . .	498,037	15,148,617	181,783,407
10	Electro-gas semaphore. . . . .	53,859	1,638,201	19,658,416
22	Enclosed disc . . . . .	278,704	8,477,245	101,726,948
7	Clockwork disc . . . . .	39,302	1,195,449	14,345,387
	Total. . . . .	1,111,034	33,793,935	405,527,231

**Table III.**

**FAILURES.**

*Number of signal failures per year. (Signals not clear when block is clear.)*

Roads reporting 12,606,940 signal movements per year, included in Table II, have not returned complete data in regard to signal failures, and are therefore not included in this compilation.

Number of roads.	SIGNALS.	Average number of failures per day.	Average number of failures per month.	Total number of failures per year.	Total number of signal movements per year.	Average number of signal movements per year.	Number of roads.	False clear indications.
6	Electro-pneumatic semaphore .	4.51	137.25	1,647	88,013,073	53,438	4	25
15	Electric semaphore . . . . .	13.69	416.42	4,997	178,217,007	35,664	9	83
8	Electro-gas semaphore . . . . .	3.73	113.41	1,361	15,493,026	11,384	5	20
19	Enclosed disc . . . . .	12.28	373.42	4,481	99,577,848	22,222	10	36
4	Clockwork disc . . . . .	18.02	548.00	6,576	11,619,337	1,767	1	22
	Total. . . . .	52.23	1,588.50	19,062	392,920,291	20,613		186

**Table IV.**

**FAILURES.**

*Number of signal failures per year. (Signals not clear when block is clear.)*

Roads reporting 12,606,940 signal movements per year, included in Table II, have not returned complete data in regard to signal failures, and are therefore not included in this compilation.

Number of roads.	SIGNALS.	Account of batteries (broken jars or other parts).	Account of faulty maintenance or inspection.		Miscellaneous and unclassified.	Total.
			Signal department.	Railway department.		
6	Electro-pneumatic semaphore . . . . .	123	586	403	535	1,647
15	Electric semaphore . . . . .	919	1,399	867	1,812	4,997
8	Electro-gas semaphore . . . . .	95	593	247	426	1,361
19	Enclosed disc . . . . .	607	1,153	1,188	1,533	4,481
4	Clockwork disc . . . . .	1,143	1,829	1,201	2,403	6,576
	Total. . . . .	2,887	5,560	3,906	6,709	19,062

DETAILED CAUSES OF MISCELLANEOUS AND UNCLASSIFIED FAILURES  
ARE AS FOLLOWS :

(SIGNALS NOT CLEAR WHEN BLOCK IS CLEAR.)

*Electro-pneumatic semaphore.*

Broken air pipe . . . . .	118
— or defective mechanism . . . . .	71
— wires . . . . .	147
Foreign current . . . . .	1
Frost . . . . .	30
Lightning . . . . .	96
Malicious disturbance . . . . .	24
Short circuit . . . . .	23
Storm. . . . .	7
Unknown . . . . .	18
	<hr/>
	535

*Electric semaphore.*

Broken or defective mechanism . . . . .	105
— wires . . . . .	493
Crossed wires . . . . .	35
Foreign current . . . . .	12
Frost . . . . .	91
Grounded wires. . . . .	2
Lightning . . . . .	84
Malicious disturbance . . . . .	51
Storm. . . . .	607
Unknown . . . . .	332
	<hr/>
	1,812

*Electro-gas semaphore.*

Broken or defective mechanism . . . . .	14
— wires . . . . .	57
Crossed wires . . . . .	1
Foreign current . . . . .	4
Frost . . . . .	6
Grounded circuit . . . . .	8
Lightning . . . . .	293
Malicious disturbance . . . . .	2
Short circuit . . . . .	1
Storm. . . . .	24
Unknown . . . . .	16
	<hr/>
	426

*Enclosed disc.*

Broken glass . . . . .	3
— or defective mechanism . . . . .	6
— wires . . . . .	544
Foreign current . . . . .	137
Frost . . . . .	50
Grounded wires . . . . .	1
Lightning . . . . .	276
Malicious disturbance . . . . .	171
Short circuit . . . . .	82
Storm. . . . .	211
Unknown . . . . .	52
	<hr/>
	1,533

*Clockwork disc.*

Broken mechanism . . . . .	1
— wires . . . . .	29
Crossed wires . . . . .	1
Foreign current . . . . .	272
Frost . . . . .	1
Grounded wires . . . . .	2
Lightning . . . . .	221
Malicious disturbance . . . . .	271
Short circuit. . . . .	110
Storm. . . . .	225
Unknown . . . . .	1,270
	<hr/>
	2,403

CAUSES OF FALSE CLEAR INDICATIONS.

*Electro pneumatic semaphore.*

Broken wires . . . . .	2
Crossed wires . . . . .	1
Errors or neglect of battery men or linemen . . . . .	10
Foreign current . . . . .	7
Frozen signal . . . . .	1
Lightning . . . . .	1
Magnet wire grounded . . . . .	1
Unknown . . . . .	2
	<hr/>
	25

*Electric semaphore.*

Armature of polarized relay stuck . . . . .	1
Arm plate casting caught on broken lamp . . . . .	1
Broken glass held relay points closed . . . . .	1
— relays . . . . .	2
— crank an slot arm . . . . .	1
Crossed wires . . . . .	1
Defective mechanism . . . . .	2
Errors or neglect of battery men or linemen . . . . .	43
Foreign current . . . . .	1
Frost . . . . .	6
Grounded wires . . . . .	2
Ground on motor circuit and indicator circuit . . . . .	1
Leak in switch box. . . . .	1
Lightning . . . . .	6
Mechanism caught. . . . .	4
Residual magnetism in slot magnets . . . . .	2
Slot armature frozen to magnet heads. . . . .	2
Unknown . . . . .	5
Water leaked into relay case and frozen . . . . .	1
	<hr/>
	83

*Electro-gas semaphore.*

Cylinder lubrication became stiff from extreme cold weather and held piston . . . . .	1
Enclosed relay points frozen. . . . .	1
Errors or neglect of battery men or linemen . . . . .	13
Foreign current . . . . .	2
Lightning . . . . .	1
Mechanism caught in case . . . . .	1
Sand from gravel train, covered rail preventing contact . . . . .	1
	<hr/>
	20

*Enclosed disc.*

Broken front glass held signal clear . . . . .	2
Cross with indicator wire. . . . .	1
Derailement caused closed circuit . . . . .	1
Errors or neglect of battery men or linemen . . . . .	14
Foreign current . . . . .	8
Ice formed on signal instrument armature . . . . .	1
Lightning . . . . .	3
Malicious disturbance. . . . .	3
Mechanism caught. . . . .	1
Residual magnetism in coils of instrument . . . . .	1
Ring holding red glass broke, showing white (clear) . . . . .	1
	<hr/>
	36

*Clockwork disc.*

Errors or neglect of battery-men or linemen . . . . . 22

It will be seen by an examination of the above, that nearly all the failures as given in detail are caused by faulty inspection and maintenance or on account of storms, lightning, frost or malicious interference common to all methods of signaling.

The figures, however, state the facts as given by the railroad companies reporting, and show what results have been obtained, in other words, what the efficiency is at the present time, and under present methods of inspection and maintenance.

It will be also noted that lightning and other causes beyond human control add very largely to the total number of failures, and as such failures are not evenly distributed, any system unfortunately located may suffer unjustly in comparison.

The following tables show number of signal movements per failure, taking only such failures as are directly chargeable to the several types of apparatus, as at present designed, manufactured and installed.

*Signals not clear when block is clear.*

Number of roads.	SIGNALS.	Number of failures per year.	Total number of signal movements per year.	Average number of signal movements per failure.
6	Electro-pneumatic semaphore . . . . .	189	88,013,073	465,677
15	Electric semaphore . . . . .	105	178,217,007	1,697,305
8	Electro-gas semaphore . . . . .	14	15,493,026	1,106,644
19	Enclosed disc . . . . .	9	99,577,848	11,064,205
4	Clockwork disc . . . . .	1	11,619,337	11,619,337
	Total. . . . .	318	392,920,291	1,235,598

*False clear indications.*

Number of roads.	SIGNALS.	Number of failures per year.	Total number of signal movements per year.	Average number of signal movements per failure.
6	Electro-pneumatic semaphore . . . . .	1	88,013,073	88,013,073
15	Electric semaphore . . . . .	15	178,217,007	11,881,134
8	Electro-gas semaphore . . . . .	1	15,493,026	15,493,026
19	Enclosed disc . . . . .	6	99,577,848	16,596,308
4	Clockwork disc. . . . .	0	11,619,337	...
	Total. . . . .	23	392,920,291	17,083,491

The following tables show number of signal movements per failure, taking the unknown causes together with those directly chargeable to the several types of apparatus.

*Signals not clear when block is clear.*

Number of roads.	SIGNALS.	Number of failures per year.	Total number of signal movements per year.	Average number of signal movements per failure.
6	Electro-pneumatic semaphore . . . . .	207	88,013,073	425,184
15	Electric semaphore . . . . .	437	178,217,007	407,819
8	Electro-gas semaphore . . . . .	30	15,493,026	516,434
19	Enclosed disc . . . . .	61	99,577,848	1,632,423
4	Clockwork disc. . . . .	1,271	11,619,337	9,142
	Total . . . . .	2,006	392,920,291	193,872

*False clear indications.*

Number of roads.	SIGNALS.	Number of failures per year.	Total number of signal movements per year.	Average number of signal movements per failure.
6	Electro-pneumatic semaphore . . . . .	3	88,013,073	29,337,691
15	Electric semaphore . . . . .	20	178,217,007	8,910,850
8	Electro-gas semaphore . . . . .	1	15,493,026	15,493,026
19	Enclosed disc . . . . .	6	99,577,848	16,596,318
4	Clockwork disc. . . . .	0	11,619,337	...
	Total. . . . .	30	392,920,291	13,097,343



3<sup>rd</sup> SECTION. — WORKING.

---

[ 686 .226 ]

QUESTION XI.

---

BAGGAGE AND EXPRESS PARCELS

---

**A. BAGGAGE.** — *Handling and protection of baggage. Methods for avoiding detentions, losses and diversions in transporting.*

**Reporter :**

*All countries.* — Mr. Geo. H. DANIELS, general passenger agent, New York Central & Hudson River Railroad.

**B. EXPRESS PARCELS.** — *Handling and protection of express parcels for quick or slow delivery. Methods for avoiding detentions, losses and diversions in transporting.*

**Reporter :**

*All countries.* — Mr. J. H. BRADLEY, general traffic manager, American Express Company.

---

## QUESTION XI.

---

## CONTENTS

---

	Pages.
Sectional discussion . . . . .	1597
Sectional report . . . . .	1619
Discussion at the general meeting. . . . .	1619
Conclusions . . . . .	1622

### PRELIMINARY DOCUMENTS.

Littera *A* : Report by Geo. H. DANIELS. (See the *Bulletin* of November, 1904, p. 1459.)

Littera *B* : Report by J. H. BRADLEY. (See the *Bulletin* of January, 1905, p. 3.)

See also the separate issues (in red cover) Nos. 13 and 21.

---

## SECTIONAL DISCUSSION

---

Meeting held on May 5, 1905 (morning).

---

MR. H. TYLSTON HODGSON, PRESIDENT, IN THE CHAIR.

**Mr. J. H. Bradley, reporter.** — In presenting my report to your section, I beg to state that my understanding of the course to be pursued by me at this particular time is that I am to confine my remarks to a brief outline of the general rules or methods which, as a result of my inquiries or experience, I have found necessary for the protection of parcels in transit, and measures necessary to be adopted for reducing to a minimum the possibility of loss, damage, or diversion in transit of express parcels.

If you find upon the conclusion of my remarks, that I have not gone into detail at this time as fully as was expected of me, and that I might have undertaken to contrast briefly the methods of this country with the methods prevailing in other countries, my reply will be that I do not believe it is expected of me and to ask you to consider that I have not been present at previous sessions of the Congress and that I am the first reporter to present a paper for the consideration of your section. Consequently, I have had no opportunity to observe or to know what course will be pursued by other reporters.

The general rules or methods submitted in my report for your consideration are briefly as follows :

1° That every shipment accepted is so securely enclosed, packed and protected, as to ensure the safe transmission of its contents if handled with ordinary and usual care ;

2° That the full and complete address is inscribed upon the package with brush or with pen and ink, and in such a manner that the address is not likely to become erased or detached ;

3° That a receipt must be issued for the same ;

4° That the valuation and contents shall be ascertained, if possible, in order that, if on account of the nature of the contents or their value, unusual care and protection are required, the same may be afforded ;

5° That the wagons used for collection or delivery of shipments should be so enclosed and protected as to minimize the possibility of damage by the elements, loss by falling from the wagon, or loss by theft, and that, if possible, the drivers of vans or wagons engaged in collecting

shipments from business places, hotels and residences, should be required to discharge their shipments at the out-freight depot or clearing house at which the shipments are weighed, way-billed, packed into route trunks, or assorted into their respective runs and dispatched towards their ultimate destination, and that such shipments must not, if possible to prevent, be subjected to the loss, damage or delay, and consequent additional and unnecessary expense incident and likely to result if the shipments are unloaded, rehandled, and reloaded at intermediate offices or depots;

6° That every shipment found in bad order, either at the point of shipment or at an intermediate point, shall be immediately repaired and, if in such condition as to warrant the belief that any portion of the original contents may be missing, or broken, the package must be opened in the presence of a second party, complete transcript of the contents made and filed for future reference, and the shipment repacked and sent forward;

7° That shipments of currency, gold coin, securities and valuables will be accepted only when tendered by the shipper at the money receiving offices of the company;

8° That drivers accepting shipments of merchandise upon which the shipper has declared a value in excess of \$50, must enter such shipments upon a book provided for that purpose, and obtain a receipt for the shipments from an official authorized to receipt for them at the depot or forwarding office at which they are delivered;

9° That all employees engaged in and charged with the responsibility of despatching shipments shall be informed as to the exact location of the places reached by the company's lines, and of the location of the junction points on connecting companies' lines, and of the places on those lines which must pass through those junction points, and of the direct lines via which all shipments will reach their final destination most expeditiously and with the least number of transfers, and that the terminal points to which through cars are run must be the points at which the greatest amount of freight is to be discharged or returned, and as far as possible the points where sufficient time is had for re-shipment over connecting lines, and that in loading the freight and shipments into cars, it must be arranged according to destination in geographical order;

10° That there should be no relinquishment of the discipline by which every employee is held personally responsible for loss or damage resulting from failure to perform the duties and to exercise the vigilance and care devolving upon his position.

The dispatch of money must be immediate and its transmission uninterrupted.

Every employee having immediate custody of packages of considerable value, must write on the package over his own signature the date and hour it came into his possession.

A detention of a money shipment en route should be accepted as a warning of the existence of some irregularity in handling, or fault in selecting the route or train on which the shipment was dispatched. Immediate investigation should be instituted to ascertain the cause of detention.

Outsiders must not have access to the inner offices of express companies, or to depots where valuables are transferred from receiving rooms and safe wagons to the cars, or to the messengers' cars where valuables are checked, assorted, placed in safes or prepared for delivery to the agents at the destination points.

Acquaintances of money deliverymen must not be permitted to accompany them on their rounds of delivery.

Messengers and deliverymen must be provided with strong safes for the storing of their valuables and with assistance necessary for the protection of the same.

Money must not be delivered by train messengers to agents at stations after nightfall where

there are inadequate provisions for the safekeeping over night of packages that have arrived too late for delivery to the consignee.

Agents must be required to tender packages of money to the consignee immediately after their arrival and insist upon their acceptance and to decline to retain possession of the packages as a matter of convenience or accommodation to the consignee.

Employees must be prohibited from making mention of any shipments of that character received by them for forwarding or delivery.

I have not undertaken at this time to explain the reasons for any one of these conditions, but I have done so, I think, in my reports, except as to the money affairs, which I did not go into so extensively. I have made no reference to the mechanical appliances desirable for the prevention of loss, damage or diversion, such as the form or character of wagons, the arrangement of the interior of cars and for the movement of packages from one part of a depot to another, such as are seen in the Gare d'Orléans in Paris. We must meet this problem, I think, in New York City, but that subject has been very ably treated and written upon by an English engineer, and it is being considered now. I did not think that I was competent or that it was my place to undertake to say anything about that.

**The President.** — We are indebted to Mr. Bradley for his paper and I will now ask Mr. Skinner to read for Mr. Daniels the other paper we have on baggage. I should say that these two subjects, though very closely connected, are somewhat separate, but it has been found in previous congresses that it is better to read together papers that are more or less connected and then take the discussion upon them all afterwards.

**Mr. W. M. Skinner, secretary-reporter.** — As Mr. Daniels, owing to other engagements, found that he would be unable to present to this body the paper which as reporter he had prepared on the subject of baggage, he obtained permission from the General Secretary to allow me to appear before you and endeavour to present to you his views as set forth in the paper.

Mr. Daniels' report is divided into two parts. The second part comprises the list of questions sent out to all the companies, together with their replies. The latter will enable all the delegates to form an opinion as to how the baggage service is organized in the various countries. As regards the first part of the report, it contains Mr. Daniels' views about the service, and his opinions may be summed up in the following manner :

- 1° Avoid delay in handling passengers, luggage and obviate its going astray;
- 2° Serve the interests of the carrying companies as well as possible.

I agree with Mr. Daniels in thinking that the system followed in America fulfils these two conditions.

As regards the first point, I may say that, owing to the check system employed in America, each piece of baggage becomes a separate consignment and that, however

great the distance travelled, no passenger has to bother about his baggage which is collected at one end and delivered at the other. In case of mistakes or loss, which unfortunately cannot always be avoided, luggage is easily recovered. When anything is reported as missing to the *general baggage agent*, he promptly looks into the matter with the help of the statements drawn up by the station and train-baggage man. By telegraphing, the luggage is easily recovered and sent on to its proper destination, where it is handed over to the owner after removing the attached checks. In subsequent journeys, a trunk does not, therefore, have old labels which may give rise to mistakes or loss.

Mr. Daniels believes the system used reduces to a minimum the loss delay and damage of packages, and consequently decreases the expenses of railways under this head. He likewise thinks that of all the systems in force, the one used in America necessitates the smallest number of employees. Hence comes another saving in expenditure.

Again, he draws the attention of the meeting to the fact that in the United States passengers may take 150 lb. of luggage free; this is considerably more than is allowed in many other countries.

Mr. Daniels also mentions the Russian law by which railways are liable for the luggage of passengers. This law provides that if the passenger pays a certain sum he may insure his luggage, when of exceptional value, against loss or damage up to its full value. If he does not choose to pay the excess and prefers to run the risk himself, the liability of the railway is limited to so much per lb. of luggage conveyed, according to the class of ticket taken. All reasonable and honest passengers would obviously approve a law of this kind. Russia replied as follows to question 39 asked by the reporter which ran in the manner given below :

*Is the liability of carrier for loss or damage limited by law, and if so, to what extent?*

Providing no value is set on the baggage at the time it is registered, the railroads are liable as follows : baggage checked on first class tickets, 3 rubles (\$1.56, U. S.) per pound; second class tickets 2 rubles (\$1.04, U. S.) per pound; third class tickets, 1 ruble (52 cents, U. S.) per pound. When value has been declared on the baggage, the railroad has to pay full price set at the time of registration, in case of loss, and a proportionate amount in case of damage. No amount is paid for delays. An extra charge is made when value is placed on baggage as follows : 1 1/2 kopeck (3/4 cent, U. S.) for each 100 rubles (\$52, U. S.) of value, per 100 versts (66 miles).

I believe, gentlemen, I have touched briefly upon the principal points in the report, and during the discussion that will follow, there will doubtless occur many questions relating to the method of handling baggage in this country. Seeing that the report has taken the position that this is the most preferable method, in the mind of the writer, I presume the trend of the discussion will be to show either that this method is or is not the best, and many questions will occur to you pertinent to the subject, and I am here to answer them or to throw any light upon the system in

vogue that has not already been covered in Mr. Daniels' report. I thank you for your attention. (*Applause.*)

**The President.** — I will ask now that the discussion begin and that some gentlemen will rise to make observations upon the papers that we have heard, for this is a matter that is of interest to all companies and to all people, whether railway men or private travellers, or anybody who uses or knows about railways at all.

**Sir Charles J. Owens,** London & South Western Railway, Great Britain. — Mr. Chairman and Gentlemen, the few remarks that I shall venture to make will relate more particularly to the question of baggage, and I would desire on my own behalf, and I am sure also on behalf of the other gentlemen here, to thank Mr. Daniels for his able report and the very exhaustive list of questions which he has addressed to the various companies and the answers he has secured from them. But while I would cordially thank Mr. Daniels for his paper, I should be very loath to accept the conclusion that he has arrived at, that the system of baggage handling as prevailing in America at the present moment, is the best possible system. My own opinion is that it may be a necessary system in America, a system necessary in a country where cabs are either non-existent, or are charged for at absolutely exorbitant rates, and also to a great extent necessary in a country where labor is so expensive as it is in America; but that the system works to the benefit of the passenger I could not for a moment concede. Having travelled in this country, not only on this occasion, but previously, over some very considerable distance, I have been astonished to see delicate ladies carrying their own heavy grips into and out of trains without a single hand to help them. I dare not contemplate such a condition of affairs in England (*Applause.*) Then, Sir, I have, perhaps too confidently, on approaching a terminal station handed to a man who called himself, most improperly and inaccurately, an "expressman" (*laughter*), the checks for my baggage. On one occasion, I was very anxious to be in evening dress within an hour of my arrival. I was assured by this expressman that my luggage would be at my hotel in half an hour after the arrival of the train, but one hour went, two hours, three hours, four hours, and at half-past eleven, just as I was wanting to go to bed, one piece out of four pieces of baggage arrived (*laughter*), and I had the misfortune of being obliged to go to bed without even the use of a tooth-brush. (*Laughter.*) Well, now, Sir, in England, we have a very powerful press, and the public are very fond of resorting to it, and I am quite satisfied that if the amount of inconvenience which I have personally suffered were experienced by the British public, the press would take it up to such an extent that our Parliament, which is always amenable to the press, would inflict some very heavy disabilities on the railway companies who they thought were so treating their passengers.

Perhaps I may just mention this, that from my point of view, looked at as a matter of principle, little can be said for the system which we adopt in England as regards our baggage. It is absolutely elementary, but there is a very good expression used

in the United States, that we must see how things "pan out," or, perhaps, as we put it in the English way, that "the proof of the pudding is in the eating." Now, I am inclined to say that the system which enables a passenger to get rid of his baggage immediately on his arrival at the station, which insures that it shall be again in his possession at the end of the journey, within at the most, speaking on the average, five minutes after the arrival of the train, generally within two minutes of the arrival of the train, and the system which at the same time involves that the passenger gives no care whatever to his baggage throughout the length of the journey, has in practice an immense deal to recommend it. For the information of the delegates who are here, Sir, I might say that notwithstanding the little check which we exercise over the baggage as conveyed in the United Kingdom of Great Britain and Ireland, it is really astonishing how very few are the claims made upon us for loss of baggage. (*Hear, hear.*) Roughly estimating it, I may say this, that the introduction of any system of registration of baggage in Great Britain would involve, as its initial cost, at least ten times the sum which we at present pay for lost baggage. Under those circumstances, Sir, and considering, as I have said, the great convenience to the passenger which he secures by our British system, I am compelled, however unwilling to do so, to differ from the conclusion arrived at by Mr. Daniels in his paper. (*Applause.*)

**Mr. Brisse, French Eastern Railway.** (*In French.*) — Gentlemen, I should like to make a few remarks and ask the representatives of American railways a few questions about the organization of this baggage department.

I quite believe that the best pudding is the one that a man is accustomed to find every day on his table, the one that he eats most often. (*Laughter.*) Obviously the American system is the one that requires least initiative from the passenger. The English system is the one perhaps which demands most. Preference may be accorded to one or other of the two systems, provided they work satisfactorily. But when the number of articles to be carried is large, the American system must, it seems, possess disadvantages. We know something about it from our experience on arriving at Washington. I should, therefore, like to have some additional information as the number of articles conveyed daily during the busy seasons at some of the large stations in the United States. No data on this point appear in Mr. Daniels' report. I should like to hear under what conditions the express companies, which undertake transference of this kind, manage the handling of luggage. What methods of traction do they use? How do they convey luggage from the stations to different parts of the town? What number of men are employed by one of these companies in doing the work it undertakes?

**Mr. W. M. Skinner, secretary-reporter.** — Before replying to Mr. Brisse, I would like in passing, with your kind permission, to take up briefly the three or four points brought out by Sir Charles Owens. His first point was that in this country he did not like to see ladies carrying baggage into the cars. In Mr. Daniels' report it was

not contemplated to take up the item of baggage that was carried into the coaches with the passengers, it being presumed that in this country, and in most countries, while the baggage is in possession of the passenger it is at his own risk. Consequently, the paper was intended to treat only of the baggage that was carried at the risk of the company. The first thing that occurs to a foreigner after arriving in this country, is that he has too many packages broken up into small lots, eight, ten or fifteen small lots. After he has handled them once on and off a train, he immediately secures a medium size trunk, into which he packs some five, six or seven packages and makes them into one package. He thus relieves himself of all further attention on the score of those eight or ten packages by reducing them to one and turning them over to the railroad company to handle in its baggage car, and for which he receives a baggage check. Consequently the people in this country, knowing that condition to exist, do not have much baggage to carry in and out of cars or coaches; they endeavour to put it in one package and send it along in the baggage car instead of carrying it in the coach with them.

The second point was the item of delay in the receipt of baggage after arrival at destination. The remarks of Sir Charles Owens on this point seemed to me to be hardly fair as comparing the American method with the British, for in the case of baggage in England, the passenger, immediately upon leaving the train, picks out his baggage and puts it on a cab with him; consequently, he gets it more quickly than if he turns a check over, as Sir Charles Owens aptly puts it, "to the misnamed express company", and waits for them to dig it out of eight or ten thousand other pieces and deliver it at his hotel. He could of course at an increased expense hire a cab, in this country, and by turning his check over to a porter immediately upon arrival of the train, have his baggage secured and placed upon his cab, in which case he would have it just as quickly as he does in England.

The third point was that in general the British system was preferable. In compiling the replies to these questions, it was found that Great Britain was the only country of the twenty-four or twenty-five interested in the replies that failed to give the passenger a receipt for his baggage on local movements. It was also found that they advertise as a special feature that they will give a receipt for baggage when it is destined to a continental point. This it seems to me is rather an argument against their local system, because they advertise as a special feature that they will give you a receipt if the baggage is going beyond their own line. Then again, the fact that some twenty-four or twenty-five countries found it necessary to make reports of baggage at the starting point, to give a receipt at the starting point, to make reports on trains and to make reports of receipt, would seem to create a preponderance of evidence that that system was preferable to the British system.

Mr. Brisse has asked for some statistical information which I am very sorry to say that I have not with me, but I can perhaps in a general way reply to his inquiries. He asks as to the manner in which baggage is handled at the large centers, such as New York, Chicago and Philadelphia, also the number of pieces of baggage, the mini-

mum and maximum each day, the number of trucks and the number of men used by the express companies to do the work. The terminal of the New York Central at New York is probably as good an example as can be taken in connection with the handling of baggage in America. In normal conditions, there are employed for the handling of baggage — and it must be understood that at our large terminals the baggage force is separate and distinct from the express force, and that the express companies, who in this country are usually separate and distinct corporations, employ their own men for the handling of their own freight, as we call it here, — at the Grand Central Station in New York, in normal conditions there are employed 150 men for the handling of baggage. The amount of baggage, in number of pieces, per month at the Grand Central Station, will average during the year from 150,000 to 200,000 pieces. That is when things are normal. There are certain months of the year when the baggage runs phenomenally heavy. Particularly is this true in the fall. When the passengers are returning from the resorts, we receive at the Grand Central Station, — this does not take into consideration any baggage that is forwarded out, — we receive on the average, 8,000 to 10,000 pieces a day for three or four weeks. This baggage is immediately taken from the train on trucks and conveyed into the baggage room, where it is sorted into piles according to the terminal numeral upon the check which breaks it up into reasonable sized piles so that it can be readily picked out. We probably have at the present time, at the Grand Central Station, 150 trucks used exclusively for baggage. Of course you will understand that they are not all in motion at the same time. When baggage is presented for forwarding at our terminals, it is checked, recorded, and laid on a truck on which is marked the train for which it is eventually destined. As the baggage gradually accumulates and fills that truck, it is taken to the train and loaded.

**Mr. Evelyn Cecil, M. P., London & South Western Railway.** — **Mr. Chairman and Gentlemen,** I quite agree with what Mr. Brisse said to the effect that familiarity with a system, and custom, do make it largely popular with the public, and I think also that the various conditions, which differ so much in different countries, have a good deal to do with the several systems in vogue in the different countries. But I cannot feel quite convinced, and I am sure I speak probably for a good many other delegates present, that the American system is really the best. I listened with great attention to what Mr. Skinner said in reply to my friend Sir Charles Owens, and I could not think that even if, as he claims, it is possible to deliver baggage just as quickly in America as in Europe, the advantages are all on the American side. Mr. Skinner said that if you engaged a cab and waited for your luggage at the station and drove off with it, there was just as quick delivery as was accomplished in England; but you have, in the first place, to wait a great deal longer than you do in England; you have in the next place to pay, as I understand, in this country, 25 cents per package for each piece that is delivered; you have then to hire a cab at

an enormous expense, say, 1·50 to 2 dollars, and you then reach your destination just as quickly as you would in England without having to pay any of these heavy extra charges. So that in England you may get quick delivery in any case; in America you only get that quick delivery at increased cost, and the normal condition in America is that you have to wait two or three or four hours for your baggage.

Then he says that the British system is somewhat self-condemned, because it has to advertise that passengers should ask for receipts if they desire them. I think the answer to that is that passengers do not ask for receipts, and therefore obviously do not require them. If they did need them, it is open to them to ask for them, but the fact that they do not, shows that the system is a popular one, and meets with general approval.

One or two bugbears were raised as to the losses produced by the British system, which are in fact, as Sir Charles Owens pointed out, so exceedingly small that any different system would be, owing to the increased staff required by the companies, much more costly to maintain; and as to old marks causing luggage to go astray, this misfortune practically never happens, because if the baggage is travelling on the same railway company's system, care is almost invariably taken to obliterate the old label by placing another on the top of it, and if the baggage is travelling on another system, it is obvious that the old label does not interfere at all.

I should like incidentally to observe, if I may, that the American system seems to produce a great deal of rough handling of baggage, a good deal rougher than occurs in Europe. Boxes have been seriously damaged in America. To record my own experience, I brought with me a strong leathern portmanteau, and it was so knocked about within the first week that I was here, that I was obliged to buy an American trunk. Now, that is no doubt very profitable to the American trunk makers, but I do not think it is altogether creditable to the system of baggage transfer. (*Laughter.*)

And, lastly, I want just to call attention, for I do not think sufficient emphasis has been laid upon it, to a point which certainly deserves more special notice. It is what Mr. Skinner has said about the Russian law. The Russian law apparently limits the liability of railways, provided no value is declared on the baggage, to certain moderate sums regulated according to the class of ticket taken by the passenger. That is a very good law, and if it existed in no other country, I think it would be right that this section at any rate should record by speech or resolution its approval of that limitation of liability of railway companies to a certain sum unless a higher value is specially declared. I wish it existed in England, and I dare say that other delegates here would approve of its introduction on the continent of Europe.

Even if we do not quite convince each other about our respective methods of carrying luggage, I believe agreement upon this matter would be of practical value, and I hope that nothing I have said will convey the impression that I do not recognize that different customs and conditions may alter circumstances in different countries.

**Mr. Brisse.** (In French.) — In view of the criticisms advanced against the American system by some of the English delegates, it will unquestionably be well to define how this subject of conveying luggage appears so far as it concerns railways.

Some of the criticisms, and especially those which have been raised by Mr. Evelyn Cecil, bear upon two points : the first concerns the conditions of carrying out the service, *i. e.*, the conditions under which luggage is handled on American railways.

This criticism does not imply that the system is good or bad in itself.

Sir Charles Owens has brought forward another criticism. This concerns the time within which luggage after arriving is delivered to passengers in America. Here a distinction may be drawn. As regards the conveyance of articles, a railway's share is usually over when luggage has been given up to the passenger. In America, a passenger does not trouble to get his luggage himself; he holds the check that the railway has given him and he can use this check as he chooses. He can have his luggage sent on as soon as ever the train gets in. But the conditions of life are such in America that the railway cannot undertake this. A passenger has therefore, as a rule, to apply to a special agency known as an Express Company.

The criticisms levelled by Sir Charles Owens and Mr. Cecil apply rather to the express companies than to the railways.

I think from the American system there are good points to choose for the railways on the continent of Europe who register luggage, especially considering the speed with which registration is accomplished here. England is the only country in Europe where a passenger is relieved from the obligation to register his luggage. Everywhere else in Europe, luggage is registered, and the railway is responsible for it until, on giving up his slip of paper, the passenger gets back his articles and resumes the responsibility for them.

Generally speaking, when a single problem has been solved in different ways, there are chances that each of the solutions possesses certain excellent sides. The best proof of this is that we French have considered a solution, as regards the conveyance of luggage between the stations and passengers' homes — a solution that is something near the American plan. For almost all the French companies have encouraged the institution at their terminal stations in Paris of carrying agencies which, though certainly not as large as the American agencies, are already rendering valuable services to passengers.

With us there are two kinds of passengers, which is perhaps not the case in America. There is the passenger who only carries with him the luggage he needs for a very few days and who would find the English custom perfectly satisfactory.

I do not think, on the other hand, that the English custom is very convenient and very advantageous even for tourists, and particularly for English tourists who travel on the continent and are going to Switzerland and Italy with a considerable number of pieces of luggage holding what they will require to meet the necessities of life for several months. It is obvious that in proportion as the number and weight of

luggage increase, the need for registration becomes felt, and this is being felt even in England.

On the other hand, in the conveyance of luggage from the passenger's house or hotel to the station, or vice versa, the difficulties increase in proportion to the weight or number of pieces of luggage. A passenger will therefore at times be glad to be able to get an agency to undertake the carriage of his luggage.

As regards the railways themselves, we are reminded by Mr. Daniels that the American system does not differ greatly from the methods followed in Europe; at times it even offers some advantages from the standpoint of simplicity. As regards this, I shall however have a few reservations to make that have here already been expounded by other continental railways.

As regards the conveyance of luggage between the station and the passenger's home, the American system can afford to ignore some criticism which, whether justifiable or unjustifiable, ought to be levelled at the special carrying agencies rather than against the railways and the methods adopted by the latter.

As for the handling of baggage, I must say it does not seem to me quite satisfactory in America and certain precautions are conspicuous by their absence. Obviously if we had to entrust into the hands of American railway employees light trunks, card-board hat-boxes, pots of flowers, bicycles, in short, all those delicate and fragile things that are constantly being carried on our lines, the disadvantages of this speedy and brutally careless handling would be keenly felt.

Let me ask one more question with reference to the actual conduct of the luggage service on American railways.

I know that some directorates of the German railways, seduced by the advantages of the American system of registration, introduced it, but that after sufficiently long experience they were led to modify it, to such an extent that it has become practically analogous to the system long practised by the French railways. The operation of carrying luggage has indeed one delicate feature, namely the organization of the work falling upon the employee whom we call the *fourgonnier* (guard) in France.

In the United States, registered baggage has a ticket and is entered in a book from which is extracted a list that is handed to the baggage-master when the train starts. From this sheet, the baggage-master has to extract and draw up, during the run, a certain number of other lists; either for the most important places, or for junction points touched by the train.

This portion of the work that falls upon the baggage-master involves difficulties which appear to me not necessarily encountered, either under the French system, or in the system adopted by Germany. With the French baggage system, three coupons have to be prepared; a leaflet or receipt is given to the passenger; it bears a registration number. The duplicate of this leaflet which becomes what we may call the luggage way-bill, is handed to the guard with the luggage. With the help of these separate pieces of paper, he prepares the various lists which have to be given up at junction points.

In many cases, the duty on the trains is reduced to simply classifying the luggage way-bills according to stations.

I should like to learn from American delegates whether the method followed here gives complete satisfaction as regards the carrying out of the work on the trains, whether no difficulties arise and whether it does not cause mistakes.

**The President.** — Will Mr. Skinner just answer the question or two that Mr. Brisse asks now, briefly.

**Mr. W. M. Skinner, secretary-reporter.** — Mr. Chairman, the question was the method of billing the baggage, and the amount of work involved. This work is much simpler in the actual working out of the details than in the reading of them. There is a single sheet used, on which the check numbers are entered as the baggage is checked, and the description of the baggage and destination. A copy of that is handed to what is called the train-baggage-man. He, in turn, makes a similar report of all baggage handled by him. He has nothing else to do but handle baggage, and make up reports, one going to the connecting road. He makes reports relieving him from further responsibility for the baggage, and turns the baggage over to the connecting road. All of that work is more quickly done than you might think. By the telling of it, it may seem a cumbersome proposition.

**Mr. E. L. Davis, North Eastern Railway, Great Britain.** — Mr. Chairman, there are two or three points in connection with the conveyance of baggage which strike the stranger very quickly. We are told, when we compare American methods with those which prevail in England, that the faults are not with the railway companies, but with the express companies. It seems to me that you cannot cut one adrift from the other in considering the question of baggage, because we cannot get our baggage through without the assistance of the express companies. We can go from station to station, but if we want it delivered, we have no alternative but to take one of those expensive cabs or use one of those express companies in America. In England, although we have not those so called express companies, we have an arrangement by which passengers, if they wish, can send their luggage in advance, and not only that, but at the principal points, where the railway companies have their own arrangement for collecting and delivering, they can have their baggage collected from their houses, brought to the station, conveyed by train and delivered at the address where they require it, for an inclusive charge of 1 shilling per package, which compares very favourably with the charge of 75 cents or 3 shillings which you have to pay express companies if you want similar service here in America.

It seems to me that a point particularly referred to by Sir Charles Owens, has not been taken up by our American friends, and that is the trouble which passengers are put to here of carrying their baggage to the compartment in which they are travelling. You have no choice. If you have more than a gripsack, you must either have your baggage registered by the railroad company, or express company; but with a grip-

sack, and they are fairly heavy, there is here no one to help to carry these things for ladies. Have the American railway companies porters at their stations to help in carrying hand baggage to the trains? We do not see, so far, anything of the kind.

Then there is another thing I should like to mention or to ask a question about. Something has been said about the railway companies in England not giving receipts for baggage. Well, something has also been said about the very elaborate statistics taken in America to tell you how many thousand or million packages of luggage have been conveyed in a year. I do not see the use of that to a passenger. It may be of use to the railroad company, but to the man in the hotel anxiously waiting for an opportunity to put on a clean shirt, it is no satisfaction to him that he can produce his baggage check or that he can reflect on the fact that in America about 80 million packages of luggage were carried in the past twelve months. That does not help him out of his difficulty. In England, if we do not give you a receipt, we give you something more useful : we give you the baggage. (*Laughter.*)

It seems to me that there are two kinds of knowledge. I believe we who have come from England should learn all we can, and see all we can, and remember, to the best of our ability what we do see and hear. But there are two kinds of knowledge. They are both, I think, exceedingly useful : one is the knowledge of what to do, and the other is the knowledge of what not to do. It does seem to me that it will be hopeless to expect anything in the shape of absolute uniformity where the conditions governing the business differ so widely as they do in England from those which prevail on the continent and in America. In this country of magnificent distances, perhaps it may be necessary to do something in the way American railway companies or express companies do ; but in our shorter distance country, we so far have found that the public appear to be very well pleased with the arrangements made to enable them to get their luggage comfortably, safely and expeditiously. (*Applause.*)

**Honorable A. H. Holland-Hibbert**, London & North Western Railway. — Mr. Chairman, I do not think this sitting is merely to compare English with American methods in dealing with baggage, and I would ask, Sir, that you rule that this subject has been sufficiently debated. We are not in the least likely to convince each other if we sit here debating the subject until the blast of the last trump. I would suggest that we leave the mere comparison of American and English methods and take up another point. I do not know whether you have any resolutions, but I would suggest that they might be taken up at this time. If we were to pass a resolution here asking that the liabilities of railway companies for loss of baggage should be limited, that would be a reasonable resolution upon which we should all agree, but on the matter of the method of dealing with baggage we shall never agree.

**Mr. W. W. Hoy**, Central South Africa Government Railways. — Before you rule, Sir, I would like to observe that the discussion seems to me to have followed the heads placed upon the agenda, and that while we may not convince each other, we

may to a very large extent influence each other. I think that the last speaker has recorded some excellent points in his favour, and I am only waiting for some of our American friends to bring out some further points in their defence; I am pledged neither to the one system nor to the other, because we follow neither in South Africa. I would like to have an opportunity of offering a general comment on the various opinions put forth, either on one side or the other. So that, Mr. Chairman, I hope as a foreign delegate, or at least as a delegate coming from a distance, that the discussion may be continued. I suppose there may be others who share my views, and I really think that so long as the discussion is kept within what is in the agenda, the discussion should proceed.

**The President.** — I do not think that the time has come to close this discussion. It has been very interesting, and I think it has brought out a great many of the points in which English and American systems vary. We have also heard some particulars of continental systems. I think it would be useful if we heard something further about that, because American systems are not the only ones of interest here. We have had from some of the members very interesting information on the French system. Perhaps we could hear from others further information about that. (*Applause.*)

**Mr. Ch. Jenny**, representing the Southern Railway of Austria, would like to say a few words on this matter.

**Mr. Jenny**, Southern Railway of Austria. (In French and in English.) — As superintendent of the Brenner section on the Austrian Southern Railway, I only possess experience of the American system on my line. We have several steep gradients, among others the Semmering section which is the shortest road between Trieste, our most important port, and Vienna on the one hand, and between Berlin and Rome via the Brenner on the other.

There is no longer any free allowance of luggage in Austria and consequently the registration system alone has had to be applied there.

This system works very nicely with us, and it is of course much preferred by the travellers, because they are sure they will get their luggage, or in the rare case of the luggage being lost they have a right to a fixed sum per pound or kilogram lost.

As regards the English system, I may add that I have myself travelled a great deal — I was for months and months travelling in England, being sent there, and to America, by my government, in the beginning of my studies, for two years. I found that the English system was preferable to any used elsewhere. (*Applause.*) I had not the slightest difficulty in England in going over the West Coast Line or the East Coast Line, or going by the "Flying Dutchman," in getting my luggage. I only took care that my luggage was put in the same carriage I was in, because I found that each carriage had in the middle a compartment where your luggage could be taken in, and it was not possible for another traveller to get your luggage, especially

in express trains, where you are travelling hours and hours without stopping.  
(Applause.)

**Mr. Yoshio Kinoshita**, Ministry of Communications, Japan. — Mr. Chairman, one of the most important questions in discussion is the transfer system in America and in England. I will relate what we are doing in Japan in the matter. In Japan, we started our railroad according to the English method, but after several years we adopted some of the American methods, and I think I can say that what we use now might be explained as a mixed system, being partly American and partly English. The system of baggage handling in Japan is no exception to this general principle, that is the adoption of what we think the best from other countries. In the stations we have many carriages or *jinrikishas* and those carriages work under the special supervision of the railway authority. Passengers who want to take their baggage from any station to their destination can hire these carriages very cheaply : 5 cents for 2 miles or 10 cents for 3 or 4 miles. Whilst passengers enjoy the benefit of carrying their baggage with them by *jinrikishas*, which are worked almost on the same principle as the English cab system, at the same time the " transfer " system which is mostly used in America is also in operation. The only difference between our transfer system and the American practice is, that the Japanese railroads conduct the business themselves — not entrusting it to other persons as in America. We started this transfer business by the railroads two or three years ago, and, so far, the results are very satisfactory to both railroads and public. We carry this baggage for 2 1/2 cents per piece, and the railroads do not lose any money in the business. Of course every thing is very cheap in Japan and I do not boast of these cheap rates. Still, surrounding conditions being taken into consideration, I believe that it can not be said that either the *jinrikisha* fare from railway stations or the transfer charge for baggage is too high.

A certain number of railroad passengers like to carry their luggage with them ; but at the same time others do not care to carry baggage, preferring to walk or take street railway to their destination. In the latter case, they leave baggage in the station and the railroad transfer department would carry this baggage to its ultimate destination at slight expense within two or three hours after the arrival of the passengers. According to my experience, in Japan about one half to three quarters of the passengers prefer to carry their baggage with them and one quarter to one half like to send it to their destination by this cheap transfer system.

If I am not mistaken, I would like to say that the English and the American systems go to either extreme — I crave the pardon of my American and English colleagues for using such impolite terms — as it is apparent that a certain portion of railway passengers in all countries would like to take their own baggage with them and others would not care to do so. The principle of passenger business, as in many other businesses, is to investigate just what the public would like and then let them do what they would like to do. In Japan, I believe we are doing so. We

have many carriages or *jinrikishas* at the station and people can take these carriages and carry their baggage with them. Or, if they do not care to hire the carriage, they can send the baggage by the cheap transfer system. But if we go to the one extreme and use only — or more exactly speaking mainly — the transfer system, as is done in America, I believe we should experience the inconvenience of not finding any carriages in small stations, and also of the high fares in larger stations where carriages are found. On the other hand, if we were to do away with the transfer system, as in England, passengers, who did not care to hire carriages, would find some inconvenience in getting their baggage to their destination at small expense. (*Applause.*)

Mr. Stiffson, Hungarian State Railways. — Mr. Chairman, in Hungary we have perhaps the cheapest passenger fares — the well known *Zonentariff* — in Europe. I am compelled to speak about the passenger tariff too, because in my opinion, the fact of the free allowance of luggage or the highness of the tariff for carrying luggage on a certain railroad, is always a compromise with the passenger fares in force. It is an ascertained fact, that everywhere where cheap passenger rates are in force, free allowance of luggage does not exist.

As I told you, we have the *Zonentariff*. Its peculiarity is that the fares are not exactly in proportion with the distances. On the Hungarian State Railways, fares are the same for 400 or 750 kilometres (248·5 or 466 miles) or more. Surely for long-distance travellers, that is a great advantage. But as railroads must live too, with the introduction of the *Zonentariff*, free allowance of luggage ceased.

The rates for luggage are also composed after the *Zonentariff* system. We have six zones with a minimum of weight of 50 kilograms (110 lb.) and 0·50 kronen = \$0·10 (5d.).

The manipulation of the luggage is the same as in Germany. When delivering his luggage, the passenger receives an acknowledgment, which on the one hand, serves as receipt for the amount paid, on the other, when arrived at his station of destination, he claims by production of the acknowledgment the return of his luggage. Generally passengers get their luggage a few minutes after the arrival of the train. In England passengers have the same comfort and from this point of view, I think the English system is preferable to the American. It is worth noting that in Budapest we have an enterprise patronised by the railway, which enables passengers to have their luggage conveyed to their hotel or lodging. Though charges are very moderate (12 to 25 cents for 50 kilograms [5·8d. to 1s. for 110 lb.]) this enterprise is not used very much, because every man prefers to carry his luggage himself, because on the stations good and cheap carriages are always at disposition, which is much more agreeable and comfortable.

As we see, handling of luggage is so closely allied with the institutions and customs of the different countries, that it is not possible to make a resolution which will be suitable for all and I think every country will have the manner of handling the luggage it finds the best. (*Applause.*)

**Mr. A. W. Sullivan, Missouri Pacific Railway.** — Mr. Chairman, I do not wish to go into a technical discussion of this question. I just want to say a few words in a general way on the American system of handling baggage, to correct possibly some misapprehension that may exist in the minds of visitors.

The American railways have sought to simplify as much as possible the arrangements for the care of baggage upon long journeys, and to relieve the traveller of the necessity for giving his personal attention to the handling of his baggage after it has been delivered to the railway company. The methods by which these arrangements are carried into effect from the point of view of one who has been associated with it for many years, are very simple. In all the larger cities of this country, it is possible through the systems of local express service, to get transportation from the hotel or residence to the station for heavy baggage in a very short time — only an hour's preparation being necessary. It is possible, upon arriving at the station, to have baggage checked for any place in the country up to within ten minutes of the departing time of the train. For all journeys, short or long, only one transaction is necessary, and that is the checking of the baggage at the initial station. When the checking is once done, all thought of the baggage can be dismissed from one's mind until arriving at destination. The customary way of travelling in this country is somewhat different from that in other places. On journeys to be made with heavy luggage the trunks are sent independently of the small satchels which are carried by hand. The custom here is for travellers to take into the cars only such a small amount of baggage as is necessary for their personal requirements during the actual time of travelling. The effect of this system is that American railway cars are kept free from the accumulation of baggage which is to be found under other systems of handling baggage, and no matter what the length of the journey, you will always find among American travellers that they do not carry into the car more than one or two small sized satchels. The effect of that method upon the public comfort is one that should not be underestimated as it will be found, I think, taken on the whole, that the interior of our coaches, parlor and sleeping cars, are comparatively free of baggage, leaving more room for the personal convenience and comfort of passengers than under any other system. What use there can be of having the heavy baggage upon the same train or in the same car in which the traveller personally goes is something completely beyond the comprehension of the American mind. There is absolutely no necessity for it from an American point of view. All that the traveller wants to know is that his baggage will be taken care of, and that being guaranteed to him by the holding of his check, and by the general efficiency of the system, he needs to concern himself no more about it. Upon arriving at the destination, it is customary upon all of the lines for local express companies in the principal cities to send their agents out to meet the trains, and by taking up the checks of those passengers who have baggage to be delivered at a hotel or residence, relieve them entirely of the burden of any care or thought of looking after their baggage. It is just as easy to travel from New York to

San Francisco, so far as the care of baggage is concerned, as it is to make a journey of 50 miles. It makes no concern to the traveller, how many different railroads he may pass over in the course of his journey; the function to him of disposing of his baggage is one of the greatest simplicity. Now I wish to submit that in a country of large distances and long journeys, the simplicity of the arrangements to the traveller, the responsibility and general efficiency of the baggage system, is of far more consequence to the travelling public than any detail relating to how the baggage is transported between the railway station and the hotel. Moreover, a system which has gained the confidence of the public to such an extent that it is willing to entrust the care of baggage wholly to the railways must be an efficient system, in view of the vast quantity transported annually and the trifling amount lost. When to this efficiency is added the personal comfort resulting from the absence of great quantities of parcels, packages and large satchels from the space used by the passengers, there is the more reason for satisfaction with the system. (*Applause.*)

**Mr. W. W. Hoy.** — Mr. Chairman and gentlemen, there are two subjects before the meeting; I shall confine my remarks entirely to the subject of baggage. I am not surprised that the whole of the members have devoted a good deal of their consideration to that subject, and if an opportunity offers at a later stage, and with the permission of the meeting, I should also like to criticize some of the so-called “express” systems, but I do not wish to occupy too much time and will therefore confine my remarks to the subject of baggage.

I think the subject has been clearly delineated into two points, one, the details connected with the handling and transport of baggage, and the other, the principle which governs the acceptance and transport of baggage. The points detailed in regard to the various systems have been set out very clearly and the speakers have convinced me that the best system to adopt in any country is the system which can best be adapted to that country. We have discussed freely the principles followed in the United Kingdom, in America generally and on the continent. The result which has been conveyed to my mind is that there are objections probably to all systems. I am sure it would be a very happy position for railway managers to be in if they could eliminate all objections. Ideal working I think is something which is very difficult to attain and which few of us expect to realize.

With regard to the English system, with which in South Africa I think we are fairly familiar, there are probably two objections. The principal one is the possibility of the passenger obtaining possession of his baggage and afterwards denying its receipt. That phase presented itself to the administration in South Africa and of course we realize that in England you are comparatively a small area carrying a very dense population, your journeys are short, and I think they can be said to be “express”. In South Africa, as possibly in America, we have to handle baggage for long distances and through many junctions and to many routes. We have therefore been obliged to devise a system whereby we should be able to clear

ourselves of responsibility. We have carefully deliberated upon the advantages of the English system and the advantages of the American system, and we have adopted what I think could be claimed the most universal system in the world, — at any rate it is applicable on the greatest number of administrations, — and that is, the giving a receipt for baggage, whether against payment or free baggage, and delivering that baggage at its destination. These are the conditions which have influenced our system, and therefore I claim that that system is probably the best, because if we adopted the American system, I think the expense of its operation, the multiplicity of officers and men necessary to carry it out, would place it beyond our means of administration. Of course, again, that may not be a fair point of view from the American aspect, because you have a big country, a long haul and a large population and a great many junctions, but I think that we have adopted in common with some other countries, a system which is secure and at the same time economical.

In dealing with the principles of regulation, from the replies received from the many administrations, it is obvious that different regulations operate in different countries. I hope that the importance of this meeting may indicate the advisability of formulating a code of regulations for the conveyance of baggage, coupled possibly with regulations governing the liability for packages, and also if possible the establishment of uniformity in regard to the weight of free baggage conveyed. If it were possible to harmonize or standardize these conditions, I think a great advantage would result, and I think we ought to be able to put forward a resolution of that kind, because there we eliminate the details.

With regard to the system followed in America, I would like to offer one or two observations. We know that upon American railways practically no luggage is conveyed in the compartment. That may be a very desirable decision to arrive at, but I do not think it will be generally admitted as one of convenience to the public, and I am sure that that system would not be tolerated in South Africa. That may be on account of our passengers travelling, a great many of them, long distances and carrying a great deal of baggage, more baggage probably than passengers carry in England, and I am sure that the general feeling of the travelling public is that a reasonable amount of baggage should be carried in the compartment and the balance carried under a reasonable system in the van.

Now, Mr. Chairman, I took the advice tendered by the American Association, and I reduced my packages to two; I found, as I expected to find, that I should not be permitted to take these two packages, and they are both small, in the compartment. In England, I could take these two packages in the compartment, in fact I could take three or four similar size packages in the compartment, and there would be accommodation in the compartment to receive that baggage without inconvenience to passengers. If there was inconvenience to passengers, I should expect the railway administration to intervene and require the packages to be put in the van.

Now, probably the crux of the whole situation, and one that settles the whole question, is whether a man gets his baggage or not. Mr. Davis very properly said

that one's baggage is much more useful than the ticket. Well, that is just precisely my position. My baggage was conveyed in the van. I did deliver my tickets, upon the assurance which had been given out that the baggage would be properly delivered, and I am afraid I am one of a good many who have experienced a sense of disappointment.

Mr. Sullivan has said, and I accept that, that the railway administration only conveys baggage from terminal to terminal. That probably is the true position, but generally we are led to believe that the American system is the best and quickest in the world. That apparently is not the case. In America as elsewhere, agencies sometimes fail and disappointment sometimes arises. It may be that the system as it operates here, is the best for this country, and it may be also that the general expressions as to the system have been not quite accurately reflected, and that is the reason why we shall have the opportunity of discussing it further in connection with the express system.

There are several other points that I might have referred to, but I think they may be left to other speakers. I have no desire to occupy your time further than to say that I think each country will determine what is best for itself and what is cheapest. (*Applause.*)

**Mr. Alexander Wilson**, North Eastern Railway, Great Britain. — I should like to ask, Mr. Chairman, what control have the American railway companies over the expressman?

**Mr. W. M. Skinner**, *secretary-reporter*. — We have no direct responsibility for the expressman, but as the privilege of transacting the business at the station is leased to him by the railroad corporation, if his work is not satisfactory, the contract is cancelled.

**The President**. — Now, I wish to ask whether there are many others who wish to speak on these subjects, because, if so, we must continue to-morrow morning. There has been a very full discussion, however, and I think we might take the resolution of the meeting now, unless there are a considerable number who wish to speak further.

I take it then that with your approval, it is now time that a resolution should be put. The following is the resolution I submit to you :

“ That after hearing the many details of the American, continental and English systems, and each country appearing to be of opinion that its present system most fully represents its requirements, no general recommendation of any one system should be made.

“ The Congress approves the principle followed in Russia that the compensation for luggage lost by railways should be limited. ”

**Mr. Brisse**. (*In French.*) — Would it not be better to postpone voting till to-morrow so as to give time for the preparation of a final resolution? (*Agreed.*)

**Mr. W. W. Hoy.** — I have much pleasure in seconding that suggestion, Mr. Chairman. Perhaps it would be well also to add same information as to the extra charge made under the Russian system for baggage of declared value. In the reply from the Russian railways it is stated that, if no value is declared, the administration is responsible up to a certain amount; if it is declared, it is responsible for the total value. But it is not stated whether any extra charge is made for the declaration; if not, passengers might declare that the baggage is worth double its value or even more.

**The President.** — Mr Hoy's wishes shall be fulfilled. This session is now closed, and we shall meet to-morrow morning at half-past nine o'clock.

---

**Meeting held on May 6, 1905 (morning).**

---

**The President.** — The first business that I have to bring before you is this, — yesterday we read over to the meeting a provisional resolution and it was agreed that it should be amended before being submitted for approval to the section. The resolution as read yesterday was as follows roughly :

“ After hearing a large number of reports on methods pursued in America, Europe and other countries throughout the world, for the transportation and protection of baggage and express parcels, it is the opinion of the Congress that the arrangements at present adopted by the different countries best meet their varied requirements, and there are no grounds for recommending any particular system.”

In consequence of what was suggested by some of the speakers yesterday, we ought to add that the Congress approves of the regulation in Russia under which there is a limited compensation for baggage lost. After the proceedings of the session were over, however, there were two or three points raised in connection with that which make it, I think, undesirable that the section should pass the latter part of the resolution about the compensation for baggage; and therefore I would ask the section to pass this resolution that I have just read, without the attachment of the clause about the compensation in Russia that was suggested yesterday.

— Adopted.

**The President.** — There is one other matter I have been asked to bring forward in connection with our work yesterday. This is a letter from Mr. Bradley, who was the reporter on the subject of express parcels :

“ It is evident from the discussion held at the meeting yesterday on the subject of the transfer or delivery of baggage, that some of the members of the section have

confused the regular express companies engaged in the transportation by passenger trains of merchandise and parcels, with the transfer companies engaged in the transfer at intermediate points, or delivery to owner at destination points, of baggage checked and transported by a railway company for its passengers. Will you state to the members that the regular express companies do not deliver or transfer or have anything to do with baggage checked by a railway company for its passengers unless specially employed to do so by the owner of the baggage. That service is performed by local transfer, or local express companies who have contracted with the railroad companies to perform that service under conditions acceptable to the railroad company. Those local transfer companies are not engaged in the transmission of express matter by passenger trains. ”

Mr. Bradley is anxious that I should give you this explanation.

**Mr. Brisse.** (In French.) — There has never entered our minds one atom of confusion between the express companies who undertake the business of conveying parcels in America and the local companies who transfer luggage in the large American towns.

---

# DISCUSSION AT THE GENERAL MEETING

---

Meeting held on May 11, 1905 (afternoon).

---

MR. STUYVESANT FISH, PRESIDENT, IN THE CHAIR.

GENERAL SECRETARY : MR. L. WEISSENBRUCH.

ASSOCIATE GENERAL SECRETARY : MR. W. F. ALLEN.

The President read the

## Report of the 3<sup>rd</sup> section.

(See the *Daily Journal of the session*, No. 4, p. 66.)

“ Mr. J. H. BRADLEY read an abstract of his report on the question of “ Express Parcels. ”

“ Because of the close connection of this question with the question of baggage, the PRESIDENT thought that the conclusion of one also applied to the other, and that it would be proper to pass to the discussion of the baggage question.

“ Mr. W. M. SKINNER, secretary-reporter, read an abstract of the report of Mr. Geo. H. Daniels, who could not be present.

“ The conclusions of this report were then put up for discussion by the PRESIDENT.

“ Sir Charles J. OWENS (*London & South Western Railway, England*) confined his remarks to the question of baggage. He did not fully agree with the reporter's conclusion as to the superiority of the American system. He thought that this system might be necessary in a country like America, where passenger vehicles are few or very expensive and the handling is costly, but he did not think it advantageous for the passengers.

“ The lack of employees to receive parcels at the station and the delays which are caused in the delivery of baggage to the residences, would not be tolerated by the English public and would cause lively protests.

“ The speaker then proceeded to show the advantages of the system in use in England for the convenience of the traveller who can get his baggage on the arrival of the train, as well as to the railway companies, which, notwithstanding the system of not registering baggage, have only a very limited number of complaints. The speaker believed that the introduction of any kind of checking in Great Britain would cause an expense which would certainly be ten times as heavy as that resulting from actual losses and damages to baggage.

“ Mr. BRISSE (*French Eastern Railway*) would like to establish a clear distinction between the inherent defects of the organization and those due to the application of the service. The delays, due to the delivery of baggage to residences, for instance, are only a question of management. If it is desired in America to have an immediate delivery of the baggage, a cab can be hired and the baggage taken along. The American system does not, however, show very successful results, and the speaker asked the reporter for supplementary information on the operating service of the baggage delivery companies, as well as statistical data relative to the number of pieces transported, the number of employees required for handling and the cost of this operation expressed as a function of the number of pieces handled.

“ Mr. W. M. SKINNER, secretary-reporter, first replied to the objections raised by Sir Charles J. Owens. The report of Mr. Geo. H. Daniels treats only of baggage transported in baggage cars. The question of the services which the agents of the railroad may furnish to travellers in transporting their handbags, is beyond the subject. Americans have, besides, found by experience that it is better to get rid of a great number of small parcels by concentrating them in large trunks, which they let the baggage transfer companies handle, and do not carry with themselves much baggage into the passenger cars. As to the delays in delivering to the residences, the English and American systems cannot be compared, because in the latter the passenger turns over his baggage to outside companies to avoid all trouble; if he cares to take any along with him, he can do it as in England. As to the superiority of the English system, it can be seen that it is not generally appreciated, except in Great Britain, which is the only one out of twenty-four or twenty-five countries which have sent in replies to the reporter that does not use any registration method.

“ As to the statistical information demanded by Mr. Brisse, Mr. W. M. Skinner regretted not being able to furnish it as completely as he would desire. He confined himself to the following figures, which apply to the Grand Central Station in New York : in normal times, the number of railroad employees (not including the employees of the baggage transfer companies occupied in handling baggage) is 150 men; the number of parcels of baggage handled is on the average of 150,000 to 200,000 per month. During the periods of heavy traffic, especially during vacation time, for three or four weeks of each year, this number is on the average of 8,000 to 10,000 parcels per day, or 240,000 to 300,000 per month. The number of trucks used exclusively for baggage is 150.

“ Mr. Evelyn CECIL (*London & South Western Railway, England*) was not convinced by the arguments presented by Mr. W. M. Skinner. Though baggage can be taken by the passenger on his arrival, it requires much longer time than in England, and cabs cause considerable expense, so that quick delivery can only be obtained at a great expense.

“ The speaker also dwelt on the roughness with which baggage is handled in America and the much greater care which is exercised in Europe. He quoted his own personal experiences, which would certainly be confirmed by a great number of his colleagues.

“ Finally, Mr. Evelyn Cecil thought that it is suitable to call the attention of the meeting to the rules adopted by the Russian law, mentioned by Mr. W. M. Skinner; these concern the limits of responsibility of the railroads when a passenger has not stated the value of the parcel transmitted. The speaker thought that these rules are excellent and he proposed that they should be approved by the section.

“ Mr. BRISSE thought that the remarks made by the representatives of the two systems, the English and the American, lead to the conclusion that each country should possess a system corresponding to the public needs and the conditions of the service. In France, a system different from the two previously described is used; the railroad companies do not undertake to deliver the baggage to the house, but they give a receipt to the passenger. For several years past, however, the companies have encouraged a private enterprise which undertakes the house delivery of baggage entrusted to them at a reasonable charge.

“ The speaker asked for details with regard to the system of records used in America, either at terminal stations or at stations of branch roads.

“ Mr. W. M. SKINNER explained the system used in America : A single sheet is used on which each of the numbers referring to each parcel is given, together with an indication of the sort of baggage and its point of destination; a copy of this sheet is put in the hands of the train baggage man, who himself keeps a note of each piece delivered to him.

“ Mr. E. L. DAVIS (*North Eastern Railway, England*) thought it impracticable to attempt to secure uniformity in methods of transportation of baggage, and while the American system may be necessary on the long journeys made in America, the English public appears to be perfectly satisfied with the arrangements in use in England.

“ Mr. Charles JENNY, superintendent of the Brenner Division of the Austrian Southern Railways, which is the shortest line between the capitals of Germany and Italy, had had occasion to study the two systems — English and American. As no free baggage is now carried in Austria, only the checking systems would apply there. Mr. Jenny stated that the English system appears to him the best.

“ Mr. Yoshio KINOSHITA, former traffic manager of the Japanese State Railways, reported that in Japan they began with the English system; that after several years' experience, the American system was adopted in part, and that at present a mixed system is in use. At the stations there are a great many vehicles or jinrikishas which have an arrangement with the railways and carry passengers with their baggage at very low rates; at the same time, the railway companies have a system of baggage transfer from house to house. The proportion of passengers preferring the former method may be estimated at between half and three-quarters of the entire number of passengers, the balance availing themselves of the other system.

“ Mr. E. STIFFSON (*Hungarian State Railways*) stated that the Hungarian railways, which make a charge for carrying baggage, use the checking system. This system gives entire satisfaction in Hungary.

“ Mr. A. W. SULLIVAN (*Missouri Pacific Railway*) defended the American system and explained its advantages, following the baggage from the city where shipped to the residence at its destination; he showed that the delay at starting point may be greatly reduced if the traveller takes his baggage with him to the station; he dwelt strongly on the fact that the small number of packages allowed in the cars prevents crowding, and he enlarged on the advantage to the passenger of having no baggage to look after upon his arrival, whatever the length of his journey.

“ Mr. W. W. HOY (*Central South Africa Government Railways*) explained that in South Africa, where the people are familiar with the English system, it has been necessary to guard against fraud, in that the passenger, after obtaining possession of his baggage, may later deny having received it. It has, therefore, become necessary to adopt a system relieving the railway from responsibility. They have therefore had to employ a checking system in South Africa.

Mr. Alexander WILSON (*North Eastern Railway, England*) inquired what control American companies have over the agents of baggage delivery companies entrusted with baggage.

“ Mr. W. M. SKINNER replied that the baggage delivery companies themselves are responsible to the railway companies for errors of agents. When the delivery service is not satisfactory, the contracts made with the companies are rescinded.

“ Discussion being closed, the PRESIDENT proposed that the section approve the following conclusions, briefly summarizing the entire debate. ”

**The President.** — The following are the

#### CONCLUSIONS.

“ After hearing a large number of reports on methods pursued in America,  
“ Europe and other countries throughout the world, for the transportation and

“ protection of baggage and express parcels, it is the opinion of the Congress that the  
“ arrangements at present adopted by the different countries best meet their varied  
“ requirements, and there are no grounds for recommending any particular  
“ system.”

— These conclusions were adopted by the general meeting.

## MISCELLANEOUS INFORMATION

---

[ 388.57 ]

### 1. — How railwaymen are trained. The Great Western Railway lecture and Debating Society.

By ALFRED W. ARTHURTON.

(*The Railway Magazine.*)

The need of "getting together" has been recognised by railwaymen in America for many years past, and the numerous associations and clubs now in existence show to what extent they are endeavouring to do so. Meetings and conventions of the various organisations take place periodically, at which matters of particular or general railway interest are discussed. Railway clubs also exist in most of the large cities which are railroad centres, and many of them possess strong social features. The membership is largely composed of the chief officials of the railways, but other organisations, such as The General Passenger and Ticket Agents' Association, the Master Mechanics' Association, the Telegraph Superintendents' Association, the Master Car Builders' Association, etc., reach a large number of the higher grade of employees, for the rank and file the Technical Debating Society is the chief means of conference and discussion available. These societies exist in large numbers in the United States, and at their weekly or fortnightly meetings, papers of a practical or technical nature are read and discussed. Their exact position in the education of the staffs of the various railways is difficult to determine, but it is certain that they are in a great measure responsible for the high-class railroad practice which exists in America to-day. Expert railwaymen speak highly of their good effect, and are agreed that permanent success can be achieved only by frequent intercourse and discussion of the problems and difficulties confronting all.

On a great railway system there is necessarily much sub-division of labour, leading often to a departmentalism fatal to the interest and zeal of employees. The stringent duties required of a man are often so engrossing that his mind and his aspirations settle down into one little groove; he becomes incapable of proper judgment, and weighs all outside influences simply from the standpoint of his own particular work. There is no reason, however, why departmental lines should be drawn so tightly, seeing that salaries all come out of one pocket. United effort on the part of the members of one department may be often seen, but there is seldom any such effort between one department and another. What is wanted is a greater interchange of ideas, and this can be brought about by friendly intercourse and discussion.

The habit of meeting together for the discussion of railway matters is, as already shown, productive of most satisfactory results, and when, in addition, the publication of the papers and discussions is also possible, the advantages are considerably increased. Some go further, and think that a judicious distribution of carefully compiled pamphlets upon subjects of special, as well as common, interest, treated by experts in a non-technical fashion, would be an even better plan. The object of these pamphlets would be to take employees into greater confidence than at present, and make each feel that he was not merely a machine, but part of an organised whole. Without divulging state secrets, much useful information could be imparted which is at present withheld. If a new line were bought or built, or an old one reconstructed, it could be explained to the employees what advantages were expected to accrue from the change; or if a new type of engine were introduced, it could be demonstrated in what way it excelled the old type in tractive power or economy of coal consumption.

The Great Western Railway (London) Lecture and Debating Society has, from its inception, endeavoured to move somewhat along these lines. The construction of new works, the evolution or adoption of new types of locomotives; the methods of lighting; or the substitution of one form of motive power for another, have occupied the attention of its members for many meetings, and the subsequent printing and distribution of the papers, corresponds somewhat to the idea of issuing pamphlets on such subjects for the edification of the staff.

I have, in a former article, described the scheme of education provided by the directors of the Great Western Railway for their employees, but in the present instance, the initiative has been taken by the staff themselves, in forming a society for the discussion of the large number of railway questions of great interest which underlie the ordinary departmental work. Its avowed objects are, to give members an opportunity of learning something of those branches of railway work with which they are not immediately connected; to keep them up-to-date in regard to improvements in methods of transport, and appliances used in connection with transport; to improve the general tone of the clerical staff, in the matter of railway education; and to invite papers on all subjects relating to all departments, and, as far as practicable, of a more or less technical nature. The idea originated amongst a few of those interested in railway education at Paddington, and steps were at once taken to carry it out. One of their number was induced to prepare a paper on "Merchandise Rates," and the meeting was widely advertised among the staff. The attendance surpassed the hopes of the provisional committee, who, contemplating the formation of a small society, were confronted at the start with an audience of from three hundred to four hundred men. The proposal to establish a debating society was received by the meeting with acclamation, and a president and committee duly elected.

The selection and arrangement of subjects for the first programme was no easy task, although, it must be admitted, that the various officers, when asked to read papers before the society, willingly responded. Eventually dates were arranged to suit all, and a comprehensive list of lectures and debates prepared. Many of the subjects appear at first sight to be of a non-debatable character, but, strange to say, these were generally the ones upon which most discussion took place. A lecture on "Stations' Accounts," for instance, which seemed to offer little field for debate, provoked a lengthy discussion. Each speaker had his own pet theory for the better preparation of one or other of the numerous returns, until so many and radical were the changes suggested, it would have been difficult to pick the wheat out of so much chaff, had not one speaker often demolished the arguments and theories of his predecessor. Naturally, at the outset, some of the oratorical efforts were not a high standard; but a great improvement in this direction was noticeable before many debates had taken place.

The first meeting of the session brought together an audience which overflowed the large Half-Yearly Meeting Room of the company. It is said that a good start is half the battle. Certainly the committee of the Debating Society had reason to be satisfied with the immediate success of the new venture. Before the commencement of the season, nearly 500 members had been enrolled, thus demonstrating not only the need of such a society, but also the interest taken in their profession by the members of the clerical staff.

Subsequent meetings, if not so crowded as the first, showed that the interest in the subjects under discussion never flagged. The latter, as may be seen from the syllabus on the end of this article, varied from the economics of transport to the daily duties at a country station, or from the financial considerations involved in railway management to the obligations imposed by the Board of Trade on British railways. The value of rail and road motors as feeders to main lines, alternated with consideration of the most recent improvements in electric signalling apparatus, whilst an evening with the Great Western Railway Company's steamboats, paved the way for a debate on the advisability of British railway companies establishing their own services across the Atlantic.

The discussion which followed the papers was in some cases continued in the correspondence columns of the *Great Western Railway Magazine* by country members of the society, who had read the papers but were not able to be present at the meetings. Particularly was this so in the case of a paper on the best methods of working parcels traffic, the correspondence continuing for over twelve months, thus again showing the interest taken in the subjects by the staff all over the line.

An interesting feature was introduced by the provision of a lantern and screen, by means of which, in the case of a paper on the different types of Great Western Railway locomotives, for example, the various classes of engines provided by the company to meet the exigencies of modern railway practice were illustrated. Such an adjunct is of no small value to a lecturer who has to make a somewhat technical subject intelligible, as well as interesting, to a non-technical audience. At other meetings, working models were provided, and in a debate on "*Gas versus Electric Lighting for Railways*," the readers of the papers provided themselves with excellent models showing the different methods of lighting and control exercised by the rival systems both for train and station illumination.

The results of the first session were such as to inspire the committee with greater confidence for the future. Nearly 700 members had been enrolled, of whom the greater part were stationed at Paddington. About 200, however, consisted of country members located in various parts of the system, and, in order that these might share with their London brethren, at least some of the advantages to be derived from such a society, the papers, as already stated, were printed and distributed. This circulation of the papers for the benefit of those who, through illness, duty, distance, or any other cause, are unable to attend the meetings, renders the information imparted of a permanent value, and there is no doubt that much of the success of the society is attributable to such a course being adopted.

In one particular only was there at first any cause for regret. The number of members who joined in the debates was comparatively small, and it was found that the discussion was often sustained by the same members time after time. During the early part of the session, members were unable to conquer their nervousness sufficiently to make a maiden effort. A few minutes was, therefore, set apart for questions, so that those who could not attempt a speech might "break the ice" by asking one or more questions of the lecturer. Slowness of speech is a distinct drawback to a railway-man, who is frequently called upon to defend his company's

interests at conferences and elsewhere, and every effort was therefore made to induce the younger members to join in the debates.

The second session was inaugurated by a lecture on "Great Western Train Speeds, 1845-1905," by the Rev. W. J. Scott, B. A., who is so well known to readers of the *Railway Magazine*. Debates and lectures followed at alternate meetings, the latter frequently illustrated by lantern slides. So necessary has this become to the proper representation of the many subjects treated, is was thought advisable to purchase an electric lantern of the latest type, instead of hiring one when required, as at first. As previously stated, views and diagrams, when thrown upon a screen, are of immense assistance to a lecturer in illustrating the points he wishes to emphasise, and their use tended to popularise the subjects among all classes of members. Particularly was this so in a lecture on the newest and shortest route to Ireland, *via* Fishguard and Rosslare. Only by means of views could the magnitude of the operations on both sides of the Channel be realised. The construction of the harbour works and the lengthy breakwaters was easily followed by means of the views taken at various stages of the work.

The economical working of goods traffic created great interest and discussion, whilst the information brought out in the discussion on "Wholesale *versus* Retail Trade, from a Railway Point of View," enabled one to realise the amount of work the railway companies are called upon to perform in dealing with small consignments of traffic.

Evenings were also devoted to departments not commonly entering into actual railway work, although their functions are of the highest importance to the railways. The numerous ways in which legal aid is required in railway operations, and the remarkable organisation which purchases and distributes stores and materials to more than 1,000 stations and depots, were fully dealt with. The great benefit derived from water softening for locomotive purposes, was the text taken by a Swindon expert at a meeting not long since, whilst an echo of the "Fishguard" route to Ireland was heard on another occasion when the resident engineer of the new line from Clarboston Road to Letterston (Pembroke) showed in detail the various operations entailed in the construction of a new railway.

At one meeting, Mr. Lynden Macassey, the able secretary to the Royal Commission on London Traffic, lectured on the factors affecting passenger traffic in our great cities, which subject was appropriately followed at the next meeting, by a paper on the provision of workmen's trains under the Cheap Trains Act of 1883.

The Hammersmith and City Railway, the first portion of the Great Western line to be adapted to electric traction, of course, claimed a prominent place in the programme, and the newly appointed electrical engineer to the Great Western Railway, Mr. Roger Smith, described its conversion, whilst a description of the International Railway Congress of 1905, held at Washington, was given by the chief goods manager, Mr. T. H. Rendell, one of the delegates representing the Great Western Railway. At this last-named meeting, the methods and objects of the Conference were fully described, and American methods of working compared with those on this side of the Atlantic.

It may here be stated, that the president of the Society is Mr. J. C. Inglis, the General Manager, who has always taken a keen interest in its progress, and frequently takes the chair at the meetings. The vice-presidents, seventeen in number, include most of the chief officers of the company, and by their frequent attendance and contributions to the debates, show practical sympathy with the object the Society has in view.

One of the pleasing features in connection with the formation of this society was the way in which it was followed by the establishment of similar institutions on other railways. The inti-

mation in the *Railway Magazine* led to numerous inquiries, and the immediate result was that several new societies were started in Great Britain. At York, the Society of the North-Eastern Railway, under the presidency of Sir George Gibb, inaugurated a series of lectures covering a large field of railway work. The North British Railway, at Edinburgh; the London and North-Western, at Camden; and the Great Central Railway, at Nottingham, also arranged courses of lectures and debates for the staff at those places, and even as far away as Natal a society, under the presidency of Sir David Hunter, the late general manager of the Natal Government Railways, was formed on a similar basis.

This almost unanimous admission of the need for some such institution on every railway for the education and improvement of the staff, may pave the way for a wider scheme. The extension of the movement should lead to the formation of an association to which the various local societies could be affiliated. An annual conference, somewhat on the lines of the American associations named at the commencement of this article, could then be arranged, at which delegates from the various societies would attend. The gathering of representatives from all the large railway companies in Great Britain, to discuss the problems of modern railway administration, which, in these days of severe competition and rapid change of circumstances, daily confront the various companies, could not fail to benefit not only the delegates themselves, but the corporations they represent. If such conferences were useful in no other way, they would serve to broaden the minds and increase the ideas of the next generation of railway officers, and prepare them to grapple with the difficulties the enormous developments of transport may hold for them in the future. It is generally admitted that the high standard of railway practice in the United States, is due in no small measure to the existence of the numerous societies for mutual intercourse and discussion already referred to. It is not too much to hope, therefore, that there may yet be established in Great Britain a general association of railwaymen, at whose meetings those already in command of our railways, may lend a helping hand to those who follow them, so that the latter may be better equipped with such knowledge as will enable them to deal satisfactorily with the problems of the future.

The establishment of debating societies on the various railways named is a step in the right direction. They are, however, purely domestic societies, and their influence consequently local. From these may spring the larger and wider scheme of gathering them into one association, which, whilst not lessening the benefits they now confer on their members, would have a far wider influence, and help to place the railway calling on a higher plane than at present. It has been recognised, that railways must be put on a scientific basis, and the railroad business must, therefore, become a profession, which, if not so old as the other scientific professions of law, medicine, etc., is no less important when it is considered to what extent we are dependent for our pleasure, our comforts, our very food, on easy and rapid means of locomotion.

At no time in the history of the nation, has the need for safe and rapid transport of person and things been more pressing than at the present time, and there is every indication that increased facilities will be demanded year by year. If steam prove insufficient, the aid of electricity must be invoked, but, in any case, the men who will in the future have control of our transport, must recognise that an applied science like transportation cannot be acquired without special training, incessant industry, and knowledge, not only of the broad principles of railway working, but also some detailed acquaintance with the various departments of which a railway is composed.

To assist in giving the latter has been the aim of the Great Western Railway (London) Lecturing and Debating Society, and its efforts have been attended with success.

that  
era  
up a  
rh-  
s of  
get  
ys.  
  
for  
be  
os  
at  
er-  
de  
a-  
of  
y-  
n  
e  
n  
:  
-  
:  
i



Fig. 1.

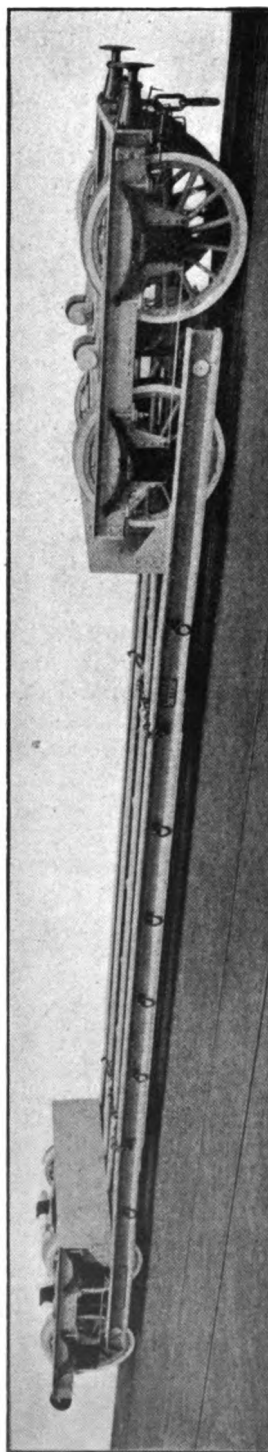


Fig. 2.

Figs. 1 and 2. — Diagram and photograph of 40-ton wagon, Cheshire lines system, for conveyance of machinery.

**Subjects discussed. — Sessions, 1904-05-06.**

SUBJECT.	INTRODUCED BY
The functions of railways in relation to trade and commerce . . . .	Mr. T. H. Rendell.
Stations' accounts . . . . .	Mr. W. Fox.
A day's work at a roadside station . . . . .	Mr. H. R. Griffiths.
Light railways, or motor cars, as feeders to main lines . . . . .	Mr. C. Aldington.
Board of Trade requirements . . . . .	Mr. F. Potter.
Great Western Railway locomotives . . . . .	Mr. G. H. Burrows, A. M. I. Mech. E.
Recent improvements in electric signalling apparatus . . . . .	Mr. C. M. Jacobs.
Stocks and shares in connection with railway management . . . .	Mr. A. E. Bolter.
Gas or acetylene lighting <i>versus</i> Electric lighting for railways . .	Mr. E. C. Riley. Mr. G. B. Clifton.
The Great Western Railway steamboat services. . . . .	Mr. T. E. Williams.
Manual <i>versus</i> Power systems of signalling . . . . .	Mr. R. J. Insell.
The working of parcels traffic . . . . .	Mr. O. Velton.
Should British Railway Co.'s establish their Own Atlantic services? .	Mr. R. H. Nicholls.
Selecting, training and disciplining railwaymen . . . . .	Mr. W. Dawson.
Great Western train speeds, 1845-1905 . . . . .	Rev. W. J. Scott, B. A.
Are one, two or three classes of carriages most desirable? . . . .	(1) Mr. W. Holt. (2) Mr. H. D. Anderson. (3) Mr. A. W. Arthurton.
Harbour construction (with special reference to Fishguard) . . . .	Mr. G. Lambert-Gibson, M. I. C. E.
Wholesale <i>versus</i> Retail trade from a railway point of view . . . .	Mr. H. C. Law. Mr. R. C. Nicole.
Some considerations in the economical working of goods traffic . . .	Mr. H. L. Bowles.
The stores department of a railway . . . . .	Mr. W. H. Stanier.
The duties of a solicitor to a railway company . . . . .	Mr. J. E. Bowen.
Water softening for locomotive purposes. . . . .	Mr. Bird.
The natural, social and service factors affecting passenger traffic . .	Mr. Lynden Macassey, M. A., B. Sc., LL. D.
The Cheap Trains Act, 1883 . . . . .	Mr. S. A. Pope.
The construction of a new railway . . . . .	Mr. A. C. Cookson.
The electrification of the Hammersmith and City Railway . . . . .	Mr. Roger T. Smith.
The International Railway Congress, 1905 . . . . .	Mr. T. H. Rendell.

[ 623 .245 ]

**2. — 40-ton wagon for the conveyance of boilers,  
large castings and heavy machinery over the Cheshire lines system.**

Figs. 1 and 2, p. 1630.

(*Railway Gazette.*)

To the designs and specifications of Mr. J. G. Robinson, the chief mechanical engineer of the Great Central Railway Company, the Leeds Forge Company, Limited, have lately constructed an

interesting type of 40-ton bogie wagon for the conveyance of boilers, large castings and heavy machinery over the Cheshire lines system.

The wagon, illustrated in the accompanying photograph and diagram drawing, has a length, over buffers, of 59 ft. 3 in. and a width, over headstocks, of 7 ft. 3 in. The wheels have a diameter on tread of 4 ft. 6 in. The bogie wheel-base is 6 ft. 3 in., and the centres of bogies are 44 ft. 9 in. apart. The distance from the rail level to the floor of the wagon is 1 ft. 8  $\frac{1}{2}$  in. The buffer height is 3 ft. 5  $\frac{1}{2}$  in. from rails, and the centres of buffers 5 ft. 8  $\frac{1}{2}$  in. The journals, inside and outside, are 8 inches by 5  $\frac{1}{2}$  inches, and the centres of journals 6 ft. 4 in. apart.

The well of the wagon has an inside length of 32 feet, and a width, over plates, of 7 ft. 5 in. The wagon is fitted with hand brake on one bogie only, applying one block to each of two wheels only. When loaded to its full length, the wagon takes a load of 40 tons, but if only a central space of 12 feet is utilised, the carrying capacity is 25 tons.

[ 628 .216 ]

### 3. — The Cardwell friction draft gear and rocker side bearing.

Figs. 3 to 5, pp. 1632 to 1634.

(*Railroad Gazette*).

The Cardwell friction draft gear, illustrated herewith, has over 200 square inches of friction surface in contact in its normal state. This increases as the gear comes into action to a maximum of 252 square inches, the increasing surface contact being coincident with increasing pressure from the springs. The peculiar feature of the gear is the location of the springs outside the center sills, with provision for the bodily movement of the same with the central portion of the gear, the travel of which approximates one-half the total travel of the coupler. The special advantages claimed for this disposition of parts, is the availability of the entire space between center sills and within coupler yoke for friction parts; and accessibility of the springs for ready inspection

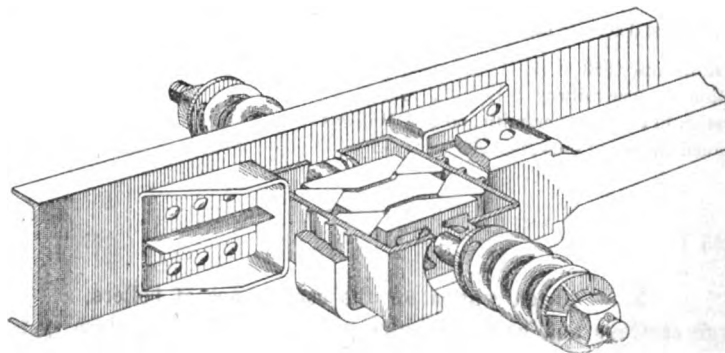


Fig. 3. — Cardwell friction draft gear.

and repair. A broken spring can be replaced without otherwise disturbing the gear, and without having to take the car to the repair track. Ease of adjustability, in case of lost motion either from wear of the friction parts, or set in the springs, is another important advantage, the tighten-

ing of the nuts on the spring rod being all that is necessary. The relation and interaction of the friction parts is such that acute wedge angles are maintained throughout the range of action of gear, making it sensitive to the action of the coupler whether the blows be light or heavy.

The friction casings or pocket follower plates surrounding the wedges, are malleable iron. The upper portion is cut away in the illustration so that the heavy transverse striking edges of the two, which limit the travel of the gear, are not seen. The springs are M. C. B. standard.

The ultimate capacity of the gear is 160,000 lb. The accompanying diagram of compression test by R. W. Hunt & Co., Chicago, was made primarily to determine the character of the release

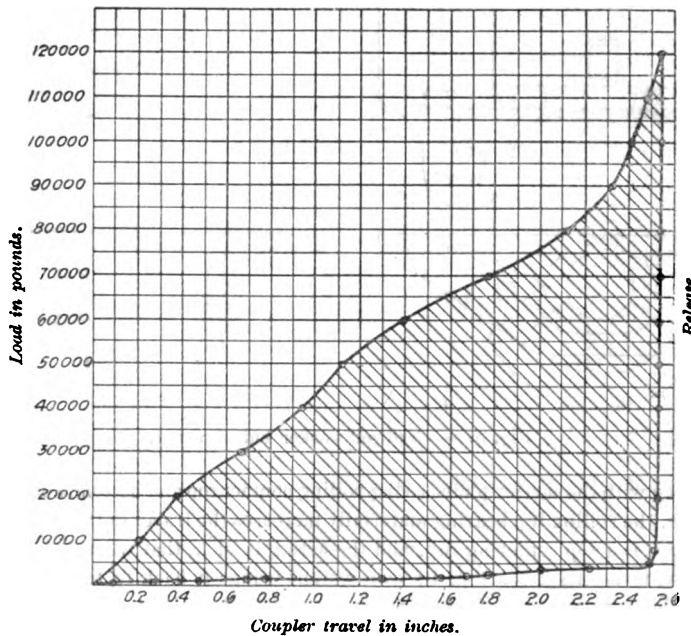


Fig. 4. — Compression test of Cardwell friction draft gear.

curve and was not carried up to the capacity of the gear. This line is practically vertical from the maximum, 120,000 lb., down to 5,000 lb. The gear tested had been in active service for eight months on the car from which it was taken. In service tests of the gear, loaded cars have been run together with relative velocities beginning with two miles per hour and increasing to 18 miles per hour without damage to cars or gear. The most practical test, however, is the results yielded from its use on a thousand cars in service for more than a year without repairs to the gears.

Four classes are made. Class A is for wooden cars. In the application to the same,  $\frac{1}{2}$  inch metallic draft plates, extending from end sill over body bolster and bolted to end and center sills and bolster, are used. Class B is for interchange with twin-spring gears. It is the type shown in the illustration. Class C takes the standard spacing recommended by the M. C. B. Association for friction gears. It has longer pocket follower plates than Class B. Class U is a special design for application to Union Tank Line cars, taking a draft lug spacing of  $23\frac{1}{2}$  inches.

The Cardwell rocker side bearing, one style of which is illustrated herewith, is quite simple, being made in three parts, namely, the rocker and the carrier for the same, the latter having a detachable side to permit insertion and removal of rocker. It will be observed that the rocker has

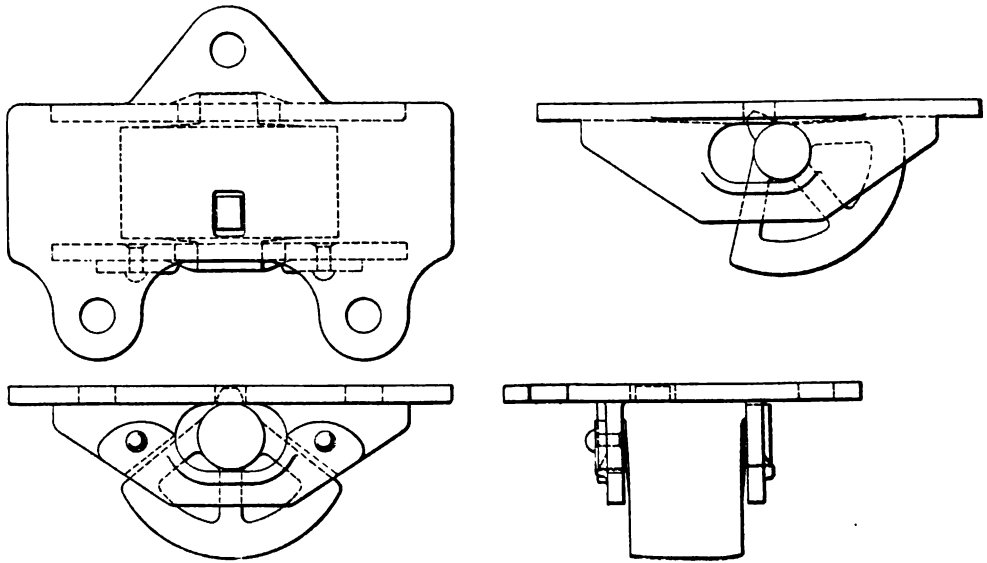


Fig. 5. — Cardwell rocker side bearing.

a rolling bearing with the carrier plate, giving rolling contact top and bottom, and thus minimizing friction. Also, the rolling top bearing materially increases the travel of the rocker. In the style illustrated, there is a top centering lug, and the action is such, that when the rocker is released from contact with the truck bearing, its own weight brings it back to the center of the slotted openings in which it rolls. All of the parts are strong and its action is positive. The top portion or carrier is made of malleable iron and the rocker of cast-iron. It weighs about 12 lb. It is in service on a considerable number of cars and is understood to be giving entire satisfaction.

Both of the devices described in the foregoing are made by the Cardwell Manufacturing Company, Chicago.

[ 621 .133.7 ]

#### 4. — Tender water scoop, Great Eastern Railway.

Figs. 6 to 8, pp. 1635 to 1637.

(*The Locomotive Magazine.*)

By the courtesy of Mr. James Holden, the locomotive, carriage and wagon superintendent of the Great Eastern Railway, we are able to show herewith a series of detail drawings illustrating the gear for picking up water applied to the tenders of main line locomotives on that railway. The scoop is operated by means of compressed air supplied from the air reservoir of the brake

apparatus, which is for this purpose divided into two compartments, one of which receives compressed air from the Westinghouse pump, and supplies power to the scoop and other gears, whilst the other compartment stores air for the brake only, which is delivered from the first compartment through a non-return valve placed on a pipe connecting the two reservoirs. Both reservoirs are, therefore, available for the supply of brake power, but only the first portion can be drawn upon to supply power for the scoop and other gears, thus preventing risk of an unintentional application of the brake.

The operation of picking up water is performed as follows : The handle T of the control valve is moved from the normal position as shown, to the position marked " down ". This causes air under pressure to be admitted by the pipe S from the air reservoir, through the control valve and pipe I to the top of the piston in the cylinder A ; the scoop is then pressed down into the trough by the descending piston, and, the engine being in motion, the water in the trough is forced up the scoop N and uptake O into the tender tank.

Enough water having been gathered up, the handle is now placed in the position marked " up ". This opens the top side of piston to exhaust and permits pressure to be transmitted through the pipe U to the underside of the piston, which ascends and lifts scoop out of trough. By then replacing the handle in the central or normal position, the air is allowed to pass freely from the cylinder, and the scoop is maintained in the " up " position by means of the coil springs M.

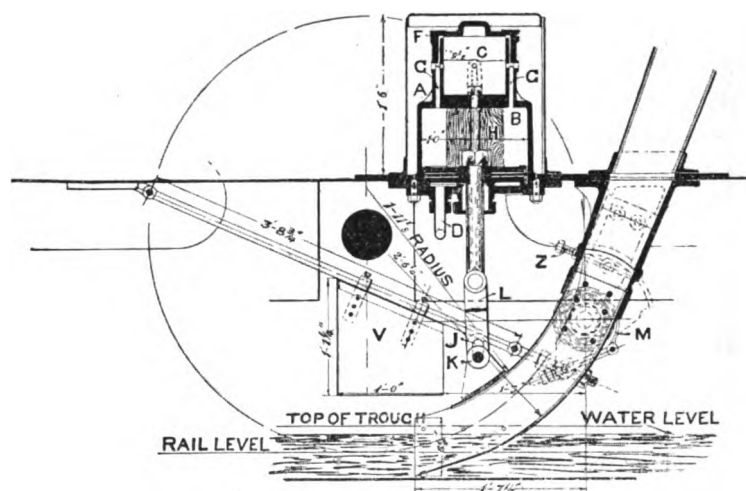


Fig. 6. — Details of cylinder and water scoop.

The air cylinder A (fig. 6), consists of two parts, a working position B and a dashpot C. Passages D and E admit pressure to the bottom and top of the cylinder respectively. In the top of the dashpot are two small ports F, and lower down four larger ones marked G. A piece of wood H is interposed between the pistons to reduce the volume of air used. The reason for forming the dashpot at the cylinder instead of at the control valve, is to provide a quicker action in working. To make the down stroke and lower the scoop, air is admitted to passage E (fig. 7),

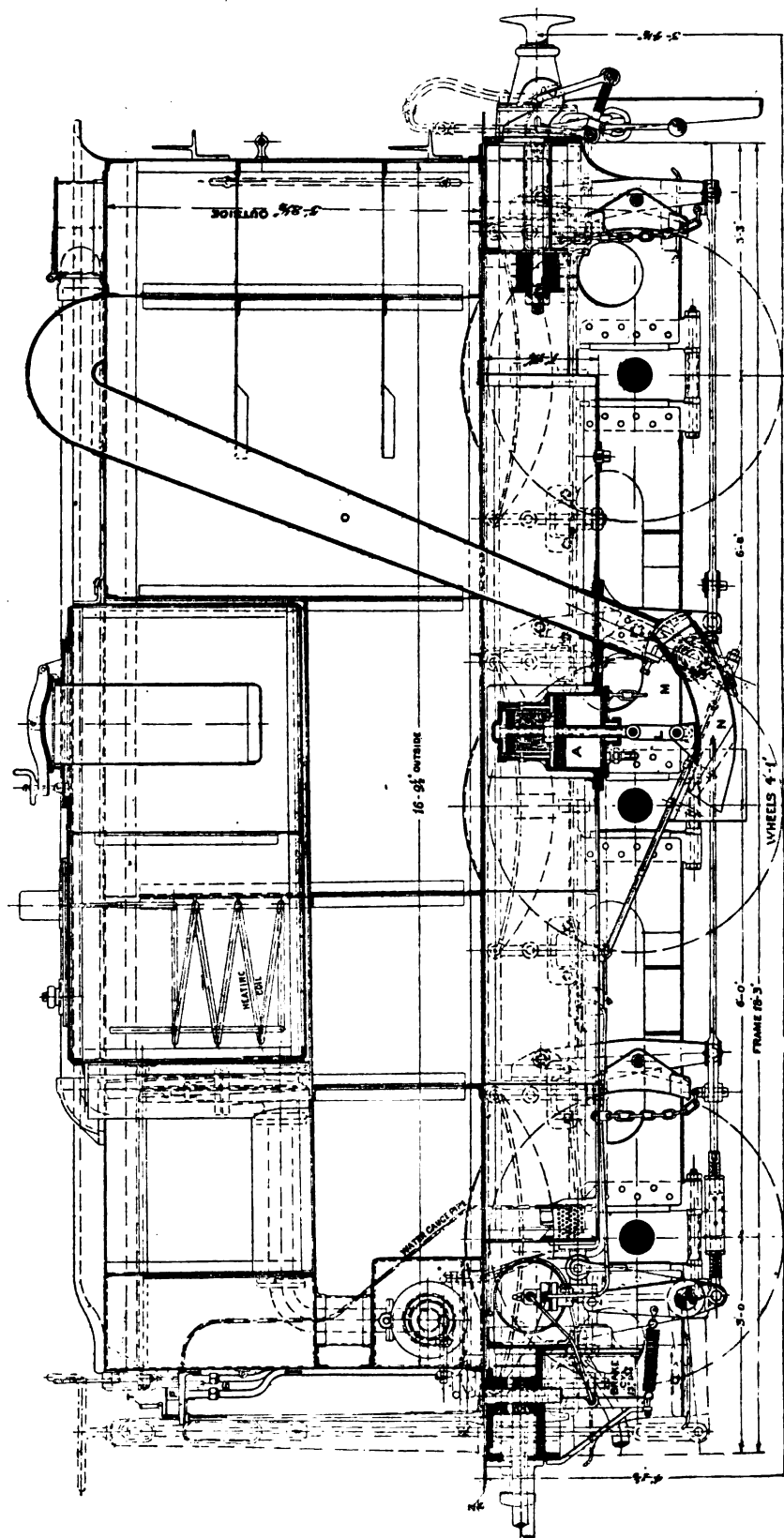


Fig. 8. — Tender fitted with water scoop, Great Eastern Railway.

and the piston in its descent pushes the scoop, to which it is attached by links L, into the trough. These links L are provided with a slot J, and when the scoop is first lowered into the trough the pin K is at top of slot, but as the resistance of the water increases, the scoop is drawn deeper into the trough, with the result that more water is supplied to the tender.

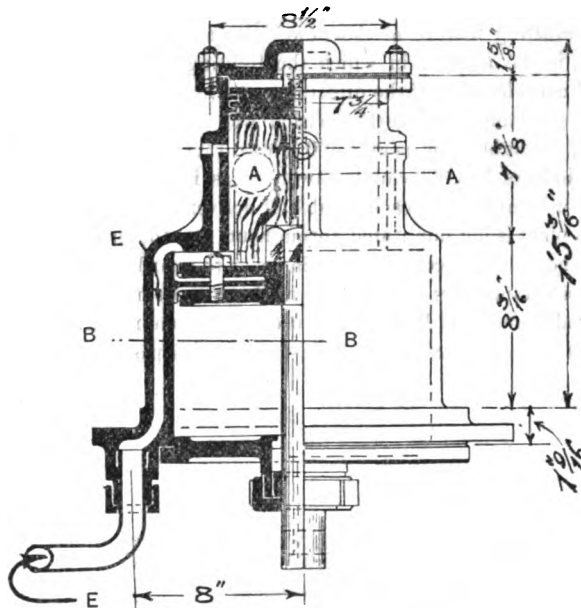


Fig. 7. — Enlarged view of cylinder.

The "up" stroke is performed by opening the passage E to exhaust through the control valve and admitting air to the bottom of the piston through D. As the piston ascends it lifts the scoop out of the trough. During this stroke, the air above the piston is exhausting through the passage E and port G. As soon as the ports G are covered up, the remaining air escapes slowly through ports F, and provides the cushioning necessary to prevent damage to the pistons from shock.

In the normal position, when there is no pressure in the cylinder, the scoop is held up into the shield V by coiled springs M. The set bolts Z are to maintain the scoop in its correct position with relation to the bottom of the trough, having regard to the wear of the tender wheels. The average amount of water picked up on passing over a trough is 1,900 gallons.

[ 686,215 ]

### 5. — The lighting of Victoria station.

Fig. 9, p. 1638.

(*The Engineer.*)

Not the least interesting feature of the new Victoria station, a large portion of which was opened last Sunday, is the manner in which the lighting of it has been effected. This point received the careful consideration of the directors, who had to decide between high-pressure gas lighting and flame arc lamps, and their decision was in favour of the former. The station, when complete, will be lighted by nearly 400 lamps, varying from 175 to 1,000 candle-power, and giving a total light of 140,000 candle-power. Gas is supplied at a pressure of 50 inches from two Sale-Onslow compressors, each capable of delivering 5,500 cubic feet per hour, driven by gas engines, the plant being duplicated throughout, and the shafting so arranged that either engine can drive either or both compressors, in order to guard against the possibility of breakdown. Two smaller compressors that can be run from the same shafting, have been fixed for use when only a small number of lights are in use. The compressors are supplied through two 500-light dry meters (George Glover), interconnected and by-passed, which are fed by a 6 inches main.

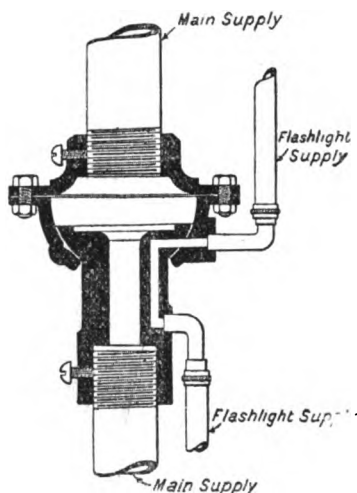


Fig. 9. — Cup and ball joint.

The platforms are lighted by Sugg's "Chertsey" pattern lamps of 350 candle-power, except in the case of those on either side of the carriage drive, which are lighted by lamps of 500 candle-power. The lamps are placed one between each pair of columns carrying the roof, so that there is an entire absence of shadow. The distance between the lamps is about 50 feet, measuring along the platform, and they are hung so that the burners are about 12 feet from the platform level. The lamps lighting each of the platform sections, are controlled by two taps placed at the end of the section, each tap controlling alternate lamps. To enable this to be done, dual services

have been run, with a third independent service for the by-pass supply. A special cup-and-ball joint shown in the figure 9, is used for connecting the down-rod of each lamp to one of the two main supplies and to the by-pass service, the one cup-and-ball serving for the two connections. Each lamp is connected to the down-rod, supplying it by a cup-and-ball, so that the effects of vibration on the mantles are reduced to a minimum. A special mercurial seal is fitted to each down-rod to prevent air getting into the pipes when the gas is shut off at the "distant-control" tap. The down-rod is also fitted with taps to enable any lamp to be removed without shutting off the supply to the platform generally. Each section of the by-pass services is fitted with a governor regulating the pressure to 2 inches. The by-passes are completely extinguished by the action of lighting the lamps.

The station yard beyond the platforms is lighted by four "Belgravia" lamps — each 1,000 candle-power — on weldless steel columns, two 25 feet and two 30 feet high, the lamps being worked by "distant-control" taps, similar to those used on the platform, placed at the base of the columns, to avoid the necessity of climbing the ladder to light or extinguish the lamps. The signals, both ground and post, are lighted by flat-flame gas burners supplied from the high-pressure services through double governors. The scheme for the lighting of the station as submitted to and approved by Mr. Charles L. Morgan, engineer to the railway company, was prepared by the Gas Light and Coke Company; the work of installation was accordingly entrusted to them, and is being carried out by their contractors — Messrs. Sugg & Co. — under the direction of the company's chief inspector, Mr. F. W. Goodenough.

[ 636 .281 ]

## 6. — The Salisbury railway accident <sup>(1)</sup>.

(*Engineering.*)

The result of the coroner's inquest on the victims of the Salisbury railway accident was made known on Monday, July 16, when the verdict announced was substantially in accord with the surmises recorded in our issue of the 6<sup>th</sup> inst. As we then pointed out, everything seemed to indicate excessive speed as the cause; and while we made this assertion with all reserve, having regard to the possibilities of failure of the road or stock, we suggested that this would ultimately be found to have been the cause of the accident. We noted that this particular spot is not one suited to high speed, and the whole of the evidence practically centred round this one question.

It appears from the evidence that the curve is a compound one of 12 chains radius, and of 8 chains radius at its sharpest part. The superelevation of the outer rail is given as 3 1/2 inches. A check or guard-rail is also provided. Had the station arrangements allowed of it, it is natural to suppose that on a main line a greater superelevation would have been given, and the running regulations relaxed accordingly; but under the peculiar circumstances, no more than this 3 1/2 inches was possible, and, therefore, special speed-limits were ordered for this spot. It was incidentally mentioned at the inquiry, that 200 trips had been made on this curve to the schedule in force, without accident, and many witnesses, some of them good authorities on these matters, stated that 30 miles per hour would be a safe speed here as from 18 to 20 miles per hour. If

---

(1) Vide *Bulletin of the Railway Congress*, No. 8, August, 1906, p. 1341.

the generally accepted formula for the relation of safe speed to superelevation be taken, it will be found that in the case of a curve of 8 chains radius the speed allowable would be only 21  $\frac{3}{4}$  miles per hour, and for one of 12 chains radius with 3  $\frac{1}{2}$  inches superelevation a rate of 26  $\frac{1}{2}$  miles per hour would be permissible. This formula, it must be allowed, is but an empirical one, and is not absolute, but merely an approximation to afford a guide in problems which are extremely difficult to solve with exactitude. A train running at excessive speed on a curve does not overturn, but the flanges striking the curve are apt to mount the rail, and so cause derailment. It is, therefore, possible that the speed allowed by competent authorities at this curve is not excessive, and, in view of the fact that trains have for years been in the habit of passing this place at 30 miles an hour in safety, this limit seems perfectly workable. Below, we deal with the actual limits in force, but we would point out that the running schedule, in which time allowance was provided sufficient to give a speed of only 26 miles at this spot, did not, it was expressly stated, cancel the 30 miles an hour regulation.

Taking then, for the moment, 30 miles an hour as the permissible speed, let us look at the actual speeds of this trip. The superintendent of the line, basing his remarks on the times booked by the signalmen in the cabins along the road, stated that the speeds worked out as follow : Between Tisbury and Dinton the figures show an average speed of 64 miles an hour ; between Dinton and Wilton the speed averaged nearly 70 miles per hour ; and between Wilton and Salisbury West it came out at 68  $\frac{1}{2}$  miles per hour. These speeds are admittedly safe on these sections. The distance of Wilton from Salisbury West box is 2 miles and 24 chains, and for the first portion of this section the road is uphill, and the engine and train would, under ordinary circumstances, lose speed. For more than a mile, however, into Salisbury the road falls, the greater part of this descent being on a gradient of 1 in 115. On this portion, therefore, it is evident that, in order to reach the average of 68  $\frac{1}{2}$  miles per hour, the train was actually travelling, towards the close of this section, at a still higher speed. This, however, in itself would be no cause for accident, for, although the distance between the west and east boxes is no more than 755 yards, the speed could have easily been brought down in this distance to the limit allowed.

It is at this point that all endeavours to clear up the subject collapse miserably, and the conduct of the driver, to which the accident was distinctly traceable, is, and promises to remain inexplicable, for we are met with clear and distinct evidence on the part of the guard that the brakes were not applied in order to bring the speed down. The guard, in fact, was so astonished at the usual reduction being ignored, that, by his hand-brake, and subsequently by the vacuum-brake, he drew the driver's attention to the fact. The evidence of the guard is supported by that of the chief assistant to the mechanical engineer, that the driver's handle of the vacuum-brake was in the "running" position when he examined the wrecked engine. This witness also stated that the regulator was closed and steam shut off; but cutting off steam alone would have been insufficient to reduce the speed by the desired amount, especially in view of the falling gradient just west of the station.

Here, then, the matter ends. A jury returns the verdict of excessive speed, and for this the company is responsible, as it was due to the actions of their employes. But at this point we differ from the finding of the jury, and cannot concur in their decision that blame attaches to the railway company. That the company were responsible we will allow, but not guilty, and for these reasons : In ordinary circumstances, a line having been laid out, the locomotive and traffic departments have to arrange to work in accordance with its requirements, and in this instance, it is easily shown that the required precautions were taken. The permanent-way department

here had to lay out a sharp curve (under the special circumstances unavoidable), and the limit of speed of 30 miles an hour was imposed. We now turn to see what steps were taken by the locomotive department to ensure the safe working of this section, and we find that the drivers had, as is customary, been required to attach their signatures to a notice of April 20, 1904, which notice regulated the speed to 30 miles per hour at this point. Further, two other notices were issued, one in May and one in June of the year 1904, in which it was impressed upon the drivers that they were to run to schedule time, and that greater speeds than those would be met with disapproval, and be punished by the drivers being taken off the trip. Finally, subsequent time-tables and running schedules were drawn up, whereby time sufficient was allowed between the west and east boxes to result in a speed of only 26 miles per hour. In these schedules, to which drivers must adhere under pain of punishment, the times are carefully mapped out all along the route from start to finish, from section to section, and not given in the form of through times from start to finish. In fact, these schedules alone, coupled with the penal clause, should be sufficient to obtain desired speeds without the use of notices or similar methods.

The permanent-way department, then, are clear of responsibility, and it is evident that the locomotive and traffic departments also took what may, in all reason, be considered sufficient steps to ensure safe working. They cannot, in view of these facts, be held guilty, yet the jury say that the driver's attention was not specially directed to the regulations in force for this spot before he set out. As if that were the only place, indeed, where a reduction of speed was advisable. Are men in future, when signing on each day, to have read out to them all the speed regulations, slows, etc., for that particular length of road on which they are to run? Drivers would have to get down to the sheds early enough indeed, and special clerks be employed for this especial duty. The suggestion is manifestly absurd, for cases often arise in which engines are put on to trains under circumstances when such care would be impossible, as, for instance, pilot engines at stations. The men are kept informed by notices, and other means, of speeds allowable, and it is part of their duty to keep themselves well posted in these matters, so that each may be ready to perform whatever duty he is selected for, instead of having to be coached up especially with information, for each trip. We hold, then, that the company should be considered blameless. From the time a train starts, the driver is master of the situation. He may run past signals, or behave in any other injudicious manner, and the company cannot avoid the consequences, but simply has to accept them. In this particular instance, a man of experience and of steady character was chosen — one who had a good record. The company could do no more, and we consider that the rider added to the verdict casts a most undeserved and unreasonable slur on the character of the company and its responsible officials.

---

## OBITUARY

Francis William WEBB,

Late chief mechanical engineer to the London & North Western Railway,  
Delegate to the sessions of the Railway Congress in London (1896) and Paris (1900).

Mr. F. W. Webb, late chief mechanical engineer to the London & North Western Railway, who played an important part in the English railway world, died on the 4<sup>th</sup> of June at Bournemouth, from a disease that had threatened him for some time and that obliged him to retire three years ago.

Mr. Webb assisted in the labours of the Congress during its fifth and sixth sessions and those of our readers who were present at the London meeting will remember the share he took in discussing the subject of locomotives for express trains.

Amid the bevy of brilliant men at the head of the locomotive departments of the English railways, Mr. Webb shone in the first rank and he must be regarded as one of the remarkable mechanical engineers of our time.

To Mr. Webb we owe a number of useful inventions relating to all the branches of railway operation and especially to improvements in the various parts of the locomotive; but it is above all with the development of the compound locomotive that his name will always be associated. From the time he reached the head of the locomotive department on the North Western, he interested himself in this subject and he set to work to convert one of the company's old engines into a Mallet compound. In 1881, he designed his first six wheel compound which he called the *Experiment* and this, like all the engines of the same type built at Crewe during the ten subsequent years, had two uncoupled driving axles; the rear axle was actuated by the two high pressure cylinders situated outside the frames, whilst the front pair of driving wheels was driven by the single inside low pressure cylinder placed beneath the smoke-box. In 1897, Mr. Webb introduced his four cylinder compounds, four-coupled engines, with a leading bogie. These ran exceedingly satisfactorily and are still all working. Lastly, the Crewe shops have turned out a great many four cylinder eight-wheels coupled compound goods locomotives, designed by Mr. Webb. Mr. Webb's work has been severally criticized; even before his death, he had the vexatious experience of seeing some of his patterns absolutely abandoned and the engines scrapped. But none will deny the magnitude of the results he obtained and these were due not only to his ability but also to his perseverance and self-confidence.

He was accused of being an autocrat because he demanded of his subordinates complete submission to his orders and his ideas, and because he would hardly brook any interference within his own sphere from the officials of other departments. He thus enjoyed more power than any other mechanical engineer in the United Kingdom. He was however universally respected, and every one bore testimony to his unfailing courtesy.

He was a glutton for work, and within thirty-one years more than 4,000 locomotives were designed by him and built under his supervision.

His father was a clergyman and he was born in 1835. At the age of 16, he entered the Crewe works as a pupil of the late Francis Trevithick, the first locomotive superintendent of the London & North Western. In 1859, Mr. Webb became chief draughtsman at the Crewe shops, and in 1861, when he was 26, we find him at the head of this department. In 1866, he left the company's service to become manager of some Lancashire steel works, but in 1871 he succeeded Mr. Ramsbottom as chief mechanical engineer to the London & North Western, a position which he occupied until his retirement in 1903.

Mr. Webb was one of the vice-presidents of the English Institute of Civil Engineers.

*The Managing Committee.*

## NEW BOOKS AND PUBLICATIONS

---

[ 621 .15 & 385. (04 ) ]

DEMOULIN (MAURICE), locomotive engineer, French Western Railway. — *La locomotive actuelle. Étude générale sur les types récents de locomotives à grande puissance.* Complément au traité pratique de la machine-locomotive. (The present locomotive. General study of recent types of high-power locomotives. Supplement to the practical treatise on the locomotive engine.) — One octavo volume (28 × 20 centimetres [11 × 8 inches] comprising 333 pages, 40 plates, and 132 figures in the text. — 1906, Paris, Ch. Béranger, publisher. — Price : bound, 40 francs (£1.12s.).

Mr. Demoulin's new volume is a supplement to his *Traité pratique de la machine-locomotive*, a review of which appeared at the time in the *Bulletin* <sup>(1)</sup>. Considerable developments have taken place in locomotive construction since then. Owing to the augmentation of traffic, the increase in loads and speeds, engineers have had to pay particular attention to increase in power, and Mr. Demoulin states with much reason that "the modern locomotive is more especially characterized by increased power, due to increase in grate area and heating surface, in cylinder capacity, in adhesive weight and in working pressure, and to improved utilization of the compound principle and of superheated steam..."

A study of modern types, carried out from this point of view by so well-informed an engineer as Mr. Demoulin, is thus of very great interest, and will be very much appreciated by all who wish for general information on the subject of the powerful engines of to-day.

The author in his first chapter examines the principal types in use at present, and the general designs and methods of construction which different engineers favour. The particulars given, in this chapter, about the arrangement and the size of the fire-box, are of special interest; it is on them that the increase in power in the first place depends.

The second chapter deals with the increase in the useful horse-power of the locomotive, and here we note an interesting analysis of the compound system and of superheating. In spite of the care and of the impartiality with which the author explains the relative advantages of the two systems, we feel that he, on the whole, prefers compounding. If the superheating were reduced to the lower degree of drying the steam, some uncertainty would disappear, and Mr. Demoulin expresses the opinion that slight superheating in connection with compounding will probably give the theoretically most economical solution.

"As the high-power locomotive of the future, it is now fairly certain", the author states, "must have four cylinders, it would hardly be rational not to construct it on the compound

---

<sup>(1)</sup> See *Bulletin of the Railway Congress*, No. 6, June, 1898, p. 709.

“ principle. Consequently superheating proper, with all its risks, becomes a factor of  
“ minor importance; its only object would be to improve, to a very limited extent (perhaps  
“ not more than from 3 to 5 per cent), the economy of the compound engine, but then also  
“ its risks and its difficulties would disappear. On the other hand, the future will show  
“ whether the addition of such complicated appliances as superheaters which probably  
“ require somewhat careful maintenance is of any real use, when the increased economy  
“ attained by their use is so limited in extent.

“ The application of superheat seems to involve greater expense for an equal number of  
“ cylinders, than that of the compound system, as we will show further on, as it includes  
“ the superheating apparatus and the different accessories necessary. The cost of a two-  
“ cylinder compound, using saturated steam, will be lower than that of a locomotive using  
“ superheated steam; and if we try with one of the latter to obtain the advantages which  
“ result from the use of four cylinders, its cost will be greater than that of a compound  
“ locomotive with four cranks.”

We might feel tempted to remark that the conclusions to be drawn from the preceding statement are perhaps rather premature, as superheating is still of somewhat recent date, and sufficient careful and accurate observations have not yet been made, as compared with compounding, to be able to form a conclusive opinion. But as Mr. Demoulin carefully avoids any dogmatic conclusions, we cannot find fault with him on this point.

The following chapters (III to IX) contain an interesting series of monographs on modern types of European (French, English, Belgian, German, etc.) and American locomotives. There we find, carefully arranged, a mass of useful information collected from different publications.

The author gives, at the end of his book, a number of general conclusions which seem to us to characterize very neatly the development of the locomotive and these we reproduce here :

“ The present tendencies, which are becoming more and more marked, and allow some  
“ fairly definite conclusions as to the future development of the locomotive to be drawn,  
“ may be summarized as follows :

“ 1° More and more frequent and perhaps before long general use of extended fire-  
“ boxes (with a grate area of from 3·5 to 4·5 square metres [37·68 to 48·44 square feet])  
“ with large heating surfaces, either of the Belpaire type, or with curved top, as much  
“ curved as possible or combined with the wagon-top which appears to be an interesting  
“ and possibly indispensable addition.

“ 2° Return to smooth tubes in the case of boilers with long barrels. Adoption of  
“ heating surfaces proportional to the grate area; say 300 square metres (5,229 square  
“ feet) and upwards.

“ 3° Gradual increase in the adhesive weight, either by increasing the wheel-loads, when  
“ possible, or by increasing the number of coupled wheels. Locomotives for fast trains  
“ will thus probably more and more frequently have six coupled wheels, unless it proves  
“ possible to design *Atlantic* types having an adhesive weight of at least 40 tons.

“ 4° The preceding conditions will before long involve, in Europe, the adoption of *Pacific*  
“ or *Prairie* types for quick trains; such types will make it possible to have six coupled  
“ wheels, of large diameter, and extended fire-boxes.

“ The *Atlantic* type, if still made in the future, will necessarily include the extended fire-

“ box; the possibility of using this constitutes the principal advantage of this type of locomotive.

“ In the case of the goods service, the *Consolidation* type would appear to meet, for a long time to come, the requirements of the service; but it is equally probable that the use of the extended fire-box, or at least of an enlarged fire-box, with the barrel raised a corresponding amount, will become more and more frequent.

“ For suburban services, the type with six coupled wheels between two Bissels or bogies tends to become more general. A type of the future may also be seen in the type with six coupled wheels with a trailing four-wheel or six-wheel bogie. The wheels remaining about 1.6 metres (5 ft. 3 in.) in diameter, it will be easy to have extended fire-boxes, which are however less necessary than on other types of locomotives.

“ 5° It also is probably possible to forecast the general development of a four-cylinder engine with the same number of cranks either on the same axle or on two separate coupled axles. These engines may be expected to be normally of the compound type in spite of the present tendency of some makers to have non-compounds with four cylinders. The latter type will not become more general unless the use of superheated steam, really found practicable, becomes developed to the extent those who favour it expect.

“ As regards compounds, a general increase in the ratio of the high pressure to the low pressure cylinders may be expected. As a consequence of this increase (2.8 to 3 volumes) the valve gears may be connected, or even only two valve gears may be used; this simplification would be bound to become more and more general.

“ To sum up : however powerful and perfect the present locomotive may be, it can as yet only be considered as at one of the stages in its evolution, the further development of which it is easy to foresee. ”

In conclusion, we can but repeat what we stated in 1898, that the actual execution of the work leaves nothing to be desired. We may add that the clear and concise way in which the author presents his analysis makes it pleasant as well as instructive to read.

A. H.

# List of the papers published for the Fifth Session.

ENGLISH EDITIONS (IN RED COVERS).

NUMBER of the pamphlet.	NUMBER of the Question.	TITLE OF THE QUESTION.	CONTENTS.	PRICE.		
				Excluding postage.	Including postage.	
1	XX	Brakes for light railways . . . . .	Report, by Mr. Ploeg . . . . . Addenda, by the same. . . . .	FR. 0 1 50	FR. 0 1 60	
2	V	Boilers, fire-boxes and tubes . . . . .	Report, by Mr. Ed. Sauvage . . . . .	3 -	3 15	
3	XVI	Decimal system. . . . .	— by Mr. J.-L. Wilkinson . . . . .	1 50	1 60	
4	XIX	Light railway shops . . . . .	— by Mr. Terzi . . . . .	1 50	1 60	
5	XV	The twenty-four hours day. . . . .	— by Messrs. Scolari and Rocca. . . . .	1 50	1 60	
6	XIII	Organisation. . . . .	2 <sup>nd</sup> report (for English speaking countries), by Mr. Harrison. . . . .	1 50	1 60	
7	X	Station working . . . . .	2 <sup>nd</sup> report on parts A and B (for English speak- ing countries), by Mr. Turner . . . . .	2 25	2 40	
8	XI	Signals . . . . .	2 <sup>nd</sup> report (for English speaking countries), by Mr. Thompson . . . . .	2 25	2 40	
9	I	Strengthening of permanent way in view of increased speed of trains. . . . .	1 <sup>st</sup> note, by Mr. Raynar Wilson. . . . . 2 <sup>nd</sup> report (for English speaking countries), by Mr. William Hunt . . . . .	3 -	3 20	
10	VI	Express locomotives . . . . .	Addenda by the same. . . . .	7 50	7 90	
11	II	Places in permanent way requiring special atten- tion. . . . .	Report, by Mr. Aspinall. . . . . — by Mr. Sabouret . . . . .	1 50	1 60	
12	XIII	Organisation. . . . .	1 <sup>st</sup> report (for non-English speaking countries), by Mr. Duca. . . . .	9 -	9 40	
13	VII	Rolling stock for express trains . . . . .	Report, by Mr. C.-A. Park. . . . .	2 -	2 10	
14	III	Junctions. . . . .	— by Mr. Zanotta. . . . .	3 -	3 15	
15	...	The history, organisation and results of the Inter- national Railway Congress. . . . .	Note, by Mr. A. Dubois. . . . .	2 50	2 65	
16	IX	Acceleration of transport of merchandis . . . . .	Report, by Mr. H. Lambert . . . . .	1 50	1 60	
17	XII	Cartage and delivery. . . . .	Report, by Mr. H. Twelvetrees . . . . . 1 <sup>st</sup> note, by the Belgian State Railways Ad- ministration. . . . .	1 50	1 60	
18	XI (See also N° 8)	Signals . . . . .	2 <sup>nd</sup> note, by the Western Railway of France Administration. . . . . 1 <sup>st</sup> Report (for non-English speaking countries), by Mr. Motte. . . . .	3 75	3 95	
19	XVII-A	Light feeder lines (contributive traffic). . . . .	2 <sup>nd</sup> note, by the Mediterranean Railway Company (Italy). . . . .			
20	XIV	Settlement of disputes . . . . .	3 <sup>rd</sup> note, by Mr. Theo.-N. Ely. . . . . 4 <sup>th</sup> — by the American Railway Association (Messrs. A.-W. Sullivan and F.-A. Delano). . . . .			
21	XVIII	The working of light railways by leasing com- panies. . . . .	5 <sup>th</sup> note, by Mr. Robert Pitcairn. . . . . 6 <sup>th</sup> — by Mr. A.-T. Dice. . . . .	1 50 1 50 3 75	1 60 1 60 3 95	
22	IV	Construction and tests of metallic bridges . . . . .	Report, by Mr. De Backer. . . . .	1 50	1 60	
23	X	Station working. (Methods of accelerating the shunting of trucks.) . . . . .	— by Mr. De Pori. . . . . — by Mr. de Burlet. . . . .	1 50 3 75	1 60 3 95	
24	...	Station working. (Employment of mechanical and electrical appliances in shunting.) . . . . .	Note, by Mr. W.-M. Acworth. . . . .	4 50	4 75	
25	I (See also N° 1)	Railway progress in the Dominion of Canada . . . . .	Report, by Mr. Max Eiler von Leber. . . . .	6 -	6 30	
26	XVII-B	Strengthening of permanent way in view of increased speed of trains. . . . .	1 <sup>st</sup> report on Part A (for non-English speaking countries), by Mr. J. de Richter . . . . .	1 <sup>st</sup> report on Part B (for non-English speaking countries), by Messrs. Eug. Sartiaux and A. von Boschan. . . . .	1 50 2 25	1 60 2 40
27	VIII	Relaxation of normal requirements for light rail- ways. . . . .	1 <sup>st</sup> note, on Part B, by Mr. Ast . . . . . 2 <sup>nd</sup> — by the Administration of the "Kaiser Ferdinand Nordbahn". . . . .	3 -	3 15	
28	XIV (See also N° 20)	Settlement of disputes . . . . .	Memorandum, by the Hon. Sir Charles Tupper. Report, by Mr. Ast (first part) . . . . .	6 50	6 80	
29	I (See also N° 9 and 22)	Strengthening of permanent way in view of increased speed of trains. . . . .	Report, by Messrs. Humphreys-Owen and P.-W. Meik. . . . .	1 50	1 55	
30	A	Technical information on the breaking of steel rails. . . . .	1 <sup>st</sup> note, by Mr. E.-A. Ziffer. . . . .	3 50	3 70	
31	B	— on the current cost of metal- lic compared with wooden sleepers. . . . .	2 <sup>nd</sup> — by the Hon. Thomas C. Farrer. . . . .	1 50	1 60	
32	C	Technical information on the life of wooden sleepers of different kinds, not pickled or pickled according to various processes. . . . .	Report, by Mr. Auvert . . . . .	3 -	3 15	
33	D	Technical information on locomotive crank axes. . . . .	1 <sup>st</sup> note, by the Western of France Railway. . . . . 2 <sup>nd</sup> — by the Northern of France Railway. . . . .	7 -	7 30	
34	E	— on locomotive fire-boxes . . . . .	3 <sup>rd</sup> — by Mr. Ernest Gerard . . . . .	1 50	1 55	
35	F	— on locomotive boilers . . . . .	Note, by Mr. Chas. J. Owens. . . . .	3 50	3 70	
36	G	— on the lubrication of rolling stock. . . . .	Report, by Mr. Ast (second part). . . . .	3 50	3 70	
37	H and I	Technical information on shunting engines and on the movement of the staff in different coun- tries. . . . .	Report, by Mr. Bricka . . . . . — by Mr. Kowalski . . . . . — by Mr. V. Herzenstein . . . . .	1 50 3 - 7 -	60 60 60	
38	I	Strengthening of permanent way in view of increased speed of trains. . . . .	As the information collected on this question was very incomplete, it was not dealt with. . . . .	6 -	6 30	
39	I	Strengthening of permanent way in view of increased speed of trains. . . . .	Report, by Mr. Hodeige. . . . .	3 50	3 70	
40	I	Strengthening of permanent way in view of increased speed of trains. . . . .	— by Mr. Bellerocche . . . . .	3 50	3 70	
41	I	Strengthening of permanent way in view of increased speed of trains. . . . .	— by Mr. Hubert . . . . .	3 50	3 70	
42	I	Strengthening of permanent way in view of increased speed of trains. . . . .	As the information collected on these questions was very incomplete, it was not dealt with. . . . .			

N. B. — The numbering of the pamphlets (see first col.) issued in French and English is not the same. The English editions are in red covers and the French editions in brown covers.

CONTENTS.	PAGES.	NUMBERS OF PLATES AND FIGURES.	NUMBERS of the DECIMAL CLASSIFICATION.
I. — <i>Burton and Ashby Light Railway</i> , by Seymour GLENDENNING . . .	1493	Figs. 1 to 7, pp. 1495 and 1496.	625 .61 (.42)
II. — <i>Roaring rails. A mysterious development</i> , by G. MOYLE . . .	1500	Figs. 1 to 6, pp. 1501 and 1502.	625 .143.3
III. — <i>Automatic signalling on the underground railways of London</i> . .	1507	Figs. 1 to 19, pp. 1513 to 1520.	656 .256.3 & 625 .4
IV. — <i>The Pennsylvania Railroad's extension to New York and Long Island</i> . . . . .	1527	Figs. 1 to 5, pp. 1528 to 1532.	725 .31
V. — <i>Second conference for the revision of the International convention on the transport of goods by railway</i> . . . . .	1534	...	385 .63. (04
VI. — PROCEEDINGS OF THE SEVENTH SESSION (3 <sup>rd</sup> section, working):			
Question X : <i>Automatic block-system</i> . Sectional discussion. Report of the 3 <sup>rd</sup> section. Discussion at the general meeting. Conclusions . . . . .	1547	...	656 .256.3
Appendix : Supplement to report No. 1, by C. H. PLATT . . . . .	1577	Figs. 23 to 29, pp. 1580 to 1585	656 .256.3
Question XI : <i>Baggage and express parcels</i> . Sectional discussion. Report of the 3 <sup>rd</sup> section. Discussion at the general meeting. Conclusions . . . . .	1585	...	656 .226
VII. — MISCELLANEOUS INFORMATION :			
1. <i>How railwaymen are trained : The Great Western Railway Lecture and Debating Society</i> , by Alfred W. ARTHURTON. . . . .	1624	...	385 .57
2. <i>40-ton wagon for the conveyance of boilers, large castings and heavy machinery over the Cheshire lines system</i> . . . . .	1631	Figs. 1 and 2, p. 1630.	625 .245
3. <i>The Cardwell friction draft gear and rocker side bearing</i> . . . . .	1632	Figs. 3 to 5, pp. 1632 to 1634.	625 .216
4. <i>Tender water scoop, Great Eastern Railway</i> . . . . .	1634	Figs. 6 to 8, pp. 1635 to 1637.	621 .133.7
5. <i>The lighting of Victoria station</i> . . . . .	1638	Fig. 9, p. 1638.	656 .215
6. <i>The Salisbury railway accident</i> . . . . .	1639	...	656 .281
VIII. — OBITUARY : <i>Francis William Webb</i> . . . . .	1642	...	385. (09.2
IX. — NEW BOOKS AND PUBLICATIONS :			
<i>La locomotive actuelle. Étude générale sur les types récents de locomotives à grande puissance. (The present locomotive. General study of recent types of high-power locomotives)</i> , by Maurice DEMOULIN . . . . .	1644	...	621 .13 & 385. (04
X. — MONTHLY BIBLIOGRAPHY OF RAILWAYS :			
I. <i>Bibliography of books</i> . . . . .	99	...	016 .385. (02
II. — <i>of periodicals</i> . . . . .	100	...	016 .385. (05

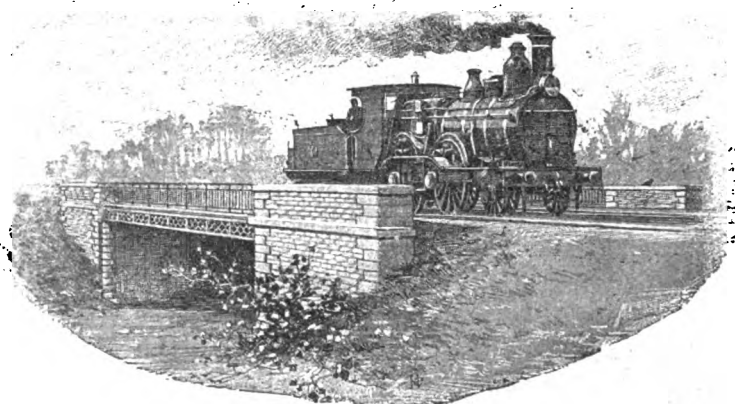
YEARLY SUBSCRIPTION (Jan. to Dec. *only*) PAYABLE IN ADVANCE, £1.4s. = \$6.

Vol. XX. — No. 11. — November, 1906. 11<sup>th</sup> Year of the English Edition.

---

**BULLETIN**  
OF THE  
**INTERNATIONAL RAILWAY CONGRESS**  
ASSOCIATION  
(ENGLISH EDITION)

[ 385. (05) ]



Editorial communications should be addressed  
to the Permanent Commission (Executive Committee) of the International Railway Congress Association  
rue de Louvain, 11, Brussels.

**BRUSSELS**  
PUBLISHED BY P. WEISSENBRUCH, PRINTER TO THE KING  
49, rue du Poinçon.

**LONDON**  
P. S. KING AND SON, PARLIAMENTARY AND GENERAL BOOKSELLERS  
2 and 4, Great Smith Street, Westminster, S. W.

The Permanent Commission of the Association is not responsible for the opinions expressed  
in the articles published in the **BULLETIN**.

# NOTICE

---

All editorial communications intended for the *Bulletin* should be addressed to Mr. Louis Weissenbruch, General Secretary of the Permanent Committee, International Railway Congress Association, 11, rue de Louvain, Brussels. The *Bulletin*, which is published in monthly numbers forming an annual volume of more than 800 pages, contains the whole of the proceedings and publications of the Congress of every kind. Copies are sent gratuitously to all the Companies, members of the Congress, at the rate of one copy for each delegate which the Company is entitled to send to a Congress meeting with one extra copy for the Company's own library.

The *Bulletin* can be supplied at the rate of 25 francs = £1 = \$5 per annum, not including postage; or 30 francs = £1.4s. = \$6 including postage to subscribers who send their subscriptions in advance by cheque or postal order direct to the publisher, Paul Weissenbruch, 49, rue du Poinçon, Brussels.

---

*N. B.* — The annual subscription, which must be paid in advance and dates from the January of the year for which the subscription is sent, does not vary even when the number of pages in the year's issue greatly exceeds 800 pages (the 1900 volume of the English edition consisted of 3988 pages). But the price of each monthly number, if bought separately, is fixed according to the number of pages it contains as follows :

2s. (50 cents) per 72 pages not including postage.

It is therefore evident that there is a great gain in subscribing for the whole year.

---

The whole years 1896, 1897, 1898, 1899, 1900, 1901, 1902, 1903, 1904 and 1905 of the English edition of the *Bulletin* containing 1,370, 1,824, 1,634, 1,695, 3,988, 2,734, 1,129, 1,353, 2,066 and 2,626 pages, may be obtained each at 35 francs = £1.8s. = \$7, including postage.

---

Previous volumes of the *Bulletin*, published in French only, contained 1,574, 1,196, 2,194, 1,576, 749, 4,114, 1,124, 1,118, 3,812 and 1,632 pages, illustrated with numerous plates and diagrams, for the years 1887 to 1896 respectively may be obtained at the same price.

---

PAPERS PUBLISHED FOR THE FIFTH SESSION : A detailed list of the papers, notes, and technical information, prepared for the London meeting, is given on the third page of the cover.

Copies may be had on application to the publisher, 49, rue du Poinçon, enclosing remittance of the price as given in the list opposite each paper on the third page of the cover. (*N. B.* 1 franc = 10d. = 20 cents.)

**BULLETIN**  
OF THE  
**INTERNATIONAL RAILWAY CONGRESS**  
**ASSOCIATION**  
(ENGLISH EDITION)

---

[ 628 .251 ]

**THE KAPTEYN APPARATUS FOR RECORDING CONTINUOUS BRAKE TRIALS,**

By **A. FUHR,**  
STATE ENGINEER.

---

Figs. 1 to 10, pp. 1649 to 1654.

---

(*Annalen für Gewerbe und Bauwesen.*)

---

The brake trial recording apparatus, with which the new experimental carriage No. 93 (Prussian State Railway) is equipped, differs from the older types in having a number of new measuring instruments. One important difference is that the coefficient of friction can easily be determined at any moment. It is well known that this coefficient varies materially with the speed, and it is very important to know what it is, if we are to ascertain how the brakes act.

The new apparatus (fig. 1) measures or records automatically :

- 1° The air pressure in the brake cylinder;
- 2° The air pressure in the main pipe;
- 3° The direct pressure exercised by the brake blocks on the wheel tires;
- 4° The tangential force resulting from the contact of the brake blocks and tire;
- 5° The beginning of the application of the brakes and the time which elapses between opening the driver's main valve and the entrance of compressed air into the brake cylinder;
- 6° The length of stop;
- 7° The running speed;
- 8° The time when the brakes begin to be taken off.

The arrangement of the measuring and recording instruments is shown in figures 2 to 4.

### Movement of the strip of paper.

The strip of paper P on which the records are made starts from the roll of paper A, passes (supported on the table) under the different recording pencils and is again rolled up on the drum E. Thus it moves from right to left, *i. e.*, in the reverse direction to that formerly adopted; this makes it easy to write in notes by hand while the trial proceeds. The strip of paper is drawn along by the driving drum C, against which another drum D is pressed by a spring; it is kept stretched by the brake rod L. The drum can be made to revolve either by the spring mechanism F (described in detail later on), at a uniform speed of 15 millimetres (0.591 inch) per second, or by the axle of the vehicle. In the latter case either 50 millimetres or 300 millimetres of travel of the paper correspond to each kilometre (3.168 inches or 1 ft. 7 in. per mile) run by the vehicle; a pinion gives the necessary adjustment. The quicker travel is more suitable for trials of short duration, such as service and emergency stops; the slower is more convenient when running down long gradients, when it is better to have shorter records, so as to make it easy to read the diagrams and deal with them.

The rotary movement of the axle is transmitted by a belt (which consists of a helical spring) to the driving pulley T, or by some other convenient means, to the worm *a*. The corresponding worm wheel, the ratchet wheel *i*<sub>1</sub>, and the bevel wheel *k*<sub>1</sub>, are firmly secured together; they run free on the main shaft as also do the ratchet wheel *i*<sub>2</sub> and the bevel wheel *k*<sub>2</sub>; the two latter wheels are also fixed to each other. A driving lever is fixed to the shaft, next to each of the ratchet wheels; each lever carries the corresponding ratchet pawl (*c*<sub>1</sub>, *c*<sub>2</sub>). As the teeth of the two ratchets are of the same hand, either one or the other ratchet, according to the direction in which the car is running, is acting against its pawl and hence drives the main shaft; thus there is a reversing gear and the shaft is always driven in the same direction, no matter whether the car is running forward or backwards. The movement of the main shaft is transmitted, through a second worm *b* and pinions, to the wheel *m*<sub>1</sub> or *m*<sub>2</sub>. When the controlling lever H (figs. 2 and 3) is placed so that the sliding pinion *w* connects wheels *n* and wheel *m*<sub>1</sub>, the paper travels at the one speed; when by a slight lateral displacement *w* connects *n* and *m*<sub>2</sub>, at the other. When the lever H (fig. 2) is in the vertical position, the strip of paper does not travel; when it is thrown over to the right, so that the toothed wheel *n*, the pinion *w* and the toothed wheel *o* are in gear, the strip of paper is still made to travel by the main shaft acting through the bevel wheels *q*<sub>1</sub> and *q*<sub>2</sub>; but the movement is converted into a uniform one by the spring mechanism F.

If trials are to be made on a train standing still, a perfectly uniform travel of the paper can be produced by turning the handle K; any irregularities in the movement of the latter are eliminated by the spring mechanism.

When a trial is finished the driving pulley T can be placed on a prolongation of shaft *e*, so that it may be protected inside the case (*T*<sub>1</sub>, in figure 2). Similarly the handle K is secured on the pin N.

### Electromagnetic recorders.

The exact time is recorded by means of the clock U, which by means of two pinions operates electromagnet *M*<sub>1</sub> of pencil 1 every six seconds and pencil *M*<sub>2</sub> every half second. The recording pencils *M*<sub>3</sub> and *M*<sub>4</sub> are in circuits in connection with the driver's main valve; when the handle is in the "brakes on" position electromagnet *M*<sub>3</sub> is excited; when in the "brakes off" position

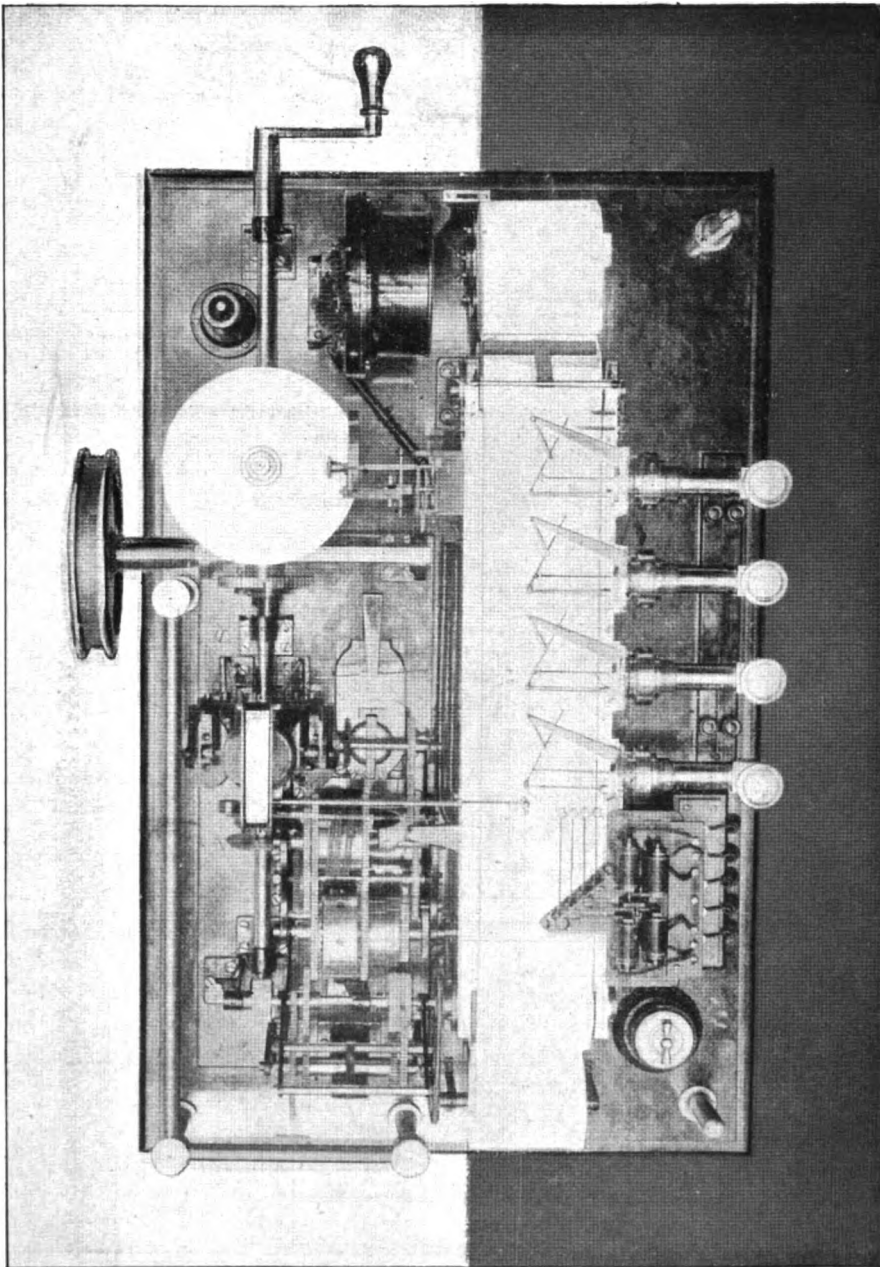


Fig. 1. — Recording apparatus, view from above.

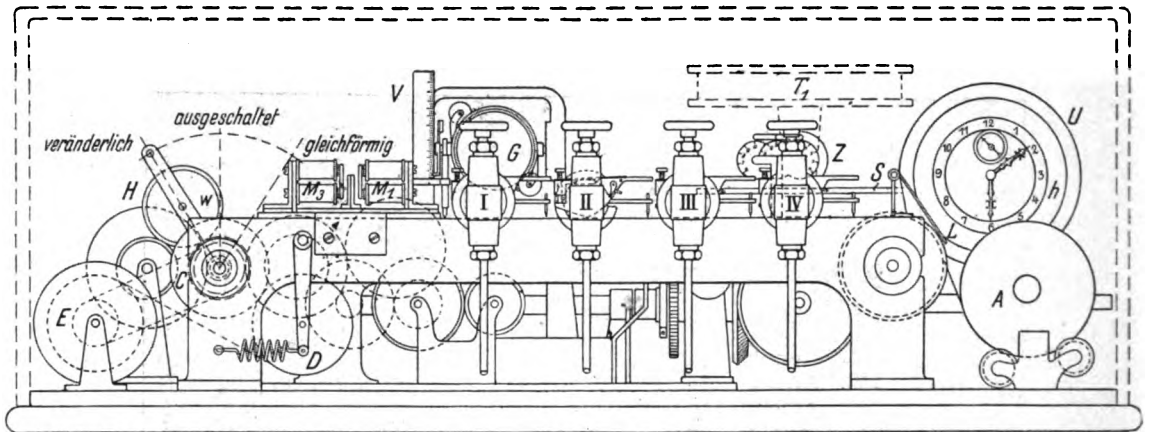


Fig. 2. — Side view.

*Explanation of German terms :* Ausgeschaltet = Out of gear. — Gleichförmig = Uniform (movement).  
Veränderlich = Variable (movement).

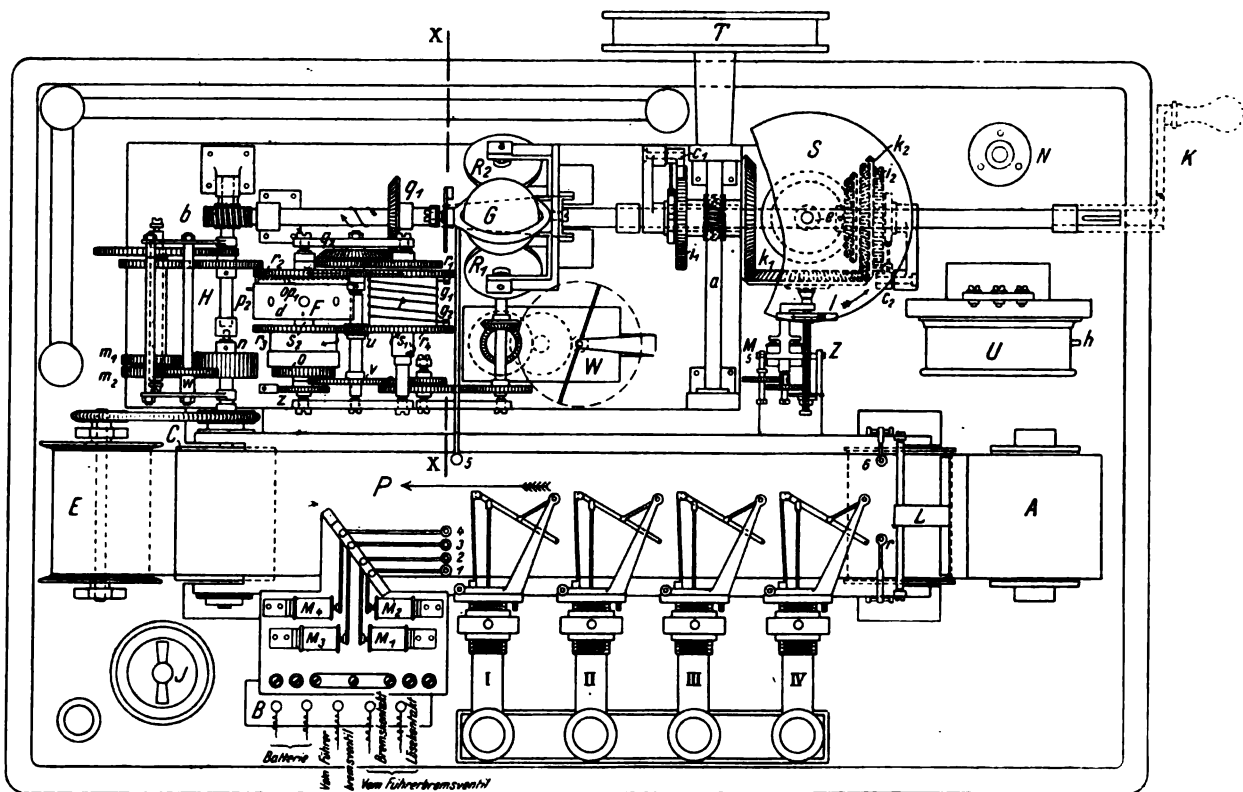


Fig. 3. — Plan.

*Explanation of German terms :* Batterie = Battery. — Bremskontakt = Contact for brakes on. — Lösekontakt = Contact for brakes off.  
Vom Führerbremsventil = From driver's valve.

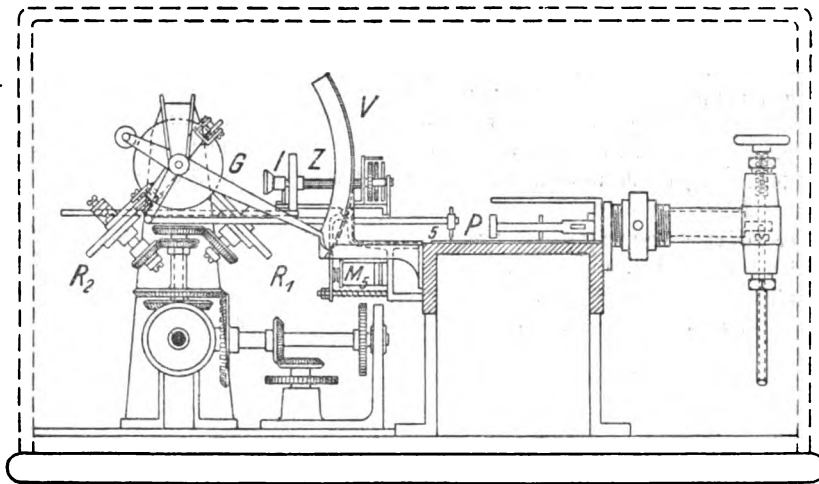


Fig. 4. — Section through X-X.

Fig. 5.

Diameter to which pressure is applied = 250 millimetres ( $9\frac{17}{16}$  inches).  
 Surface to which pressure is applied = 490 square centimetres (75.95 square inches).

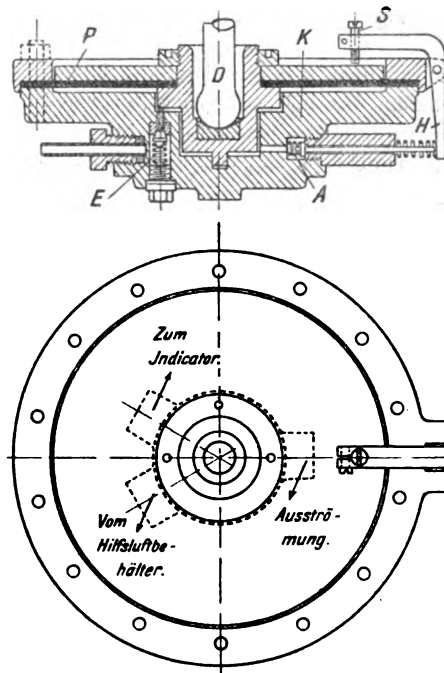


Fig. 6.

*Explanation of German terms :* Ausströmung = Exhaust. — Vom Hilfsluftbehälter = To auxiliary reservoir.  
 Zum Indicator = To indicator.

electromagnet  $M_4$  is excited. Thus pencil 3 records the beginning of the time when the brakes are applied, and pencil 4 when the brakes are beginning to be taken off.

Switchboard B, figure 3, shows how the connections are made. All the other conductors to the electromagnets, etc., are permanently fixed inside the stand, and thus are protected. The switch J makes it possible to turn on or switch off the current to all the measuring appliances simultaneously.

The seconds clock can be started or stopped, as desired by means of the small lever  $h$ , quite independently of the other appliances.

Pencil 5 records the readings of the Amsler speed gauge G, and thus gives the speed curve, whereas pencils 6 and 7 draw the zero lines for the speed and for the indicator diagrams.

### Indicators.

In order to measure the variations in pressure while the brakes are on, the indicators I, II, III and IV are used; the two latter show the variations in the brake cylinder and the main pipe. No separate indicator was provided for determining the pressure in the auxiliary reservoir, for in the majority of cases the determination of this pressure was of no special importance. Moreover this pressure is equal, in the case of service stops, to that in the main pipe; in the case of urgency stops, to that in the brake cylinder. If in special cases it is also desirable to determine the variations in pressure in the auxiliary reservoir, indicator I or II may be used for the purpose. These are connected with special dynamometers and are intended to record the pressure on the brake blocks and the resulting friction. The ratio of these two quantities represents the coefficient of friction.

In order to facilitate the examination of the diagrams, the apparatus has a metal rule with scales corresponding to the different indicator springs, engraved at suitable intervals. If an indicator is not used, all that is necessary is to raise the catch a little so that a small stop can enter a notch in the head of the indicator and keep the slide and pencil in this inclined position. (See fig. 2, indicator II.)

### Air dynamometers.

The construction of these dynamometers is shown in figures 5 and 6. Their connection with the brake gear is shown diagrammatically in figures 7 and 8; it must be designed to suit the type of frame used.

The cast iron body K (fig. 5) is closed above by an elastic plate P secured from the outside by a ring; and this plate has a boss underneath, in which the end of the rod D rests. Three tubes lead out of the inside of the box (see plan, fig. 6); one goes to the indicator, the other to an air reservoir, and the third communicates with the outer air through the valve A which is held down by a spring. The pressure of air in the auxiliary reservoir, which is fed by the main pipe through a relief-valve, must be sufficiently great to enable a force to be applied to the elastic plate, capable of counterbalancing that of the rod, when the latter is to be measured.

When a force is applied to the rod, the elastic plate is pressed downwards; the admission valve E is opened and compressed air from the air reservoir continues to enter the box until the pressure of air inside counterbalances the force on the rod. As soon as this force decreases, the plate rises and the cranked lever H opens the valve A which allows air to escape until the pressure

is sufficiently reduced to re-establish equilibrium. The screw S of the cranked lever enables the position of equilibrium to be adjusted with great nicety.

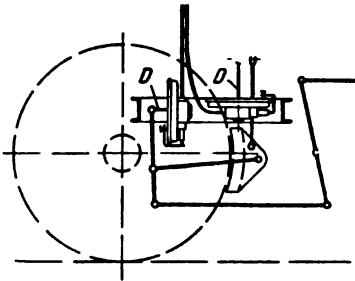


Fig. 7. — Arrangement of air dynamometer.

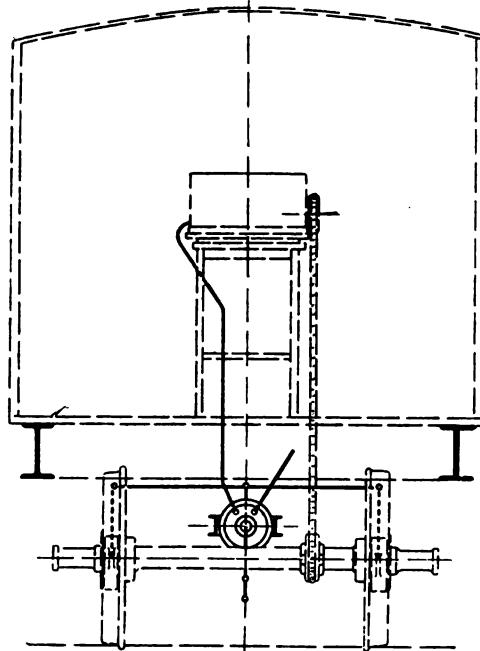


Fig. 8. — Air dynamometer and gear operating it.

#### Instrument for measuring the length of stop.

The length of stop is measured by a counter Z, operated by a small roller *l* which is in contact with the disk S (fig. 2). This disk is fixed to a shaft *e* which is operated by the main shaft through bevel gear. As the electromagnet  $M_5$  is on the same circuit as the recording electromagnet  $M_3$  which shows when the brakes are put on, the roller is pressed, as soon as the brakes are put on, against the disk S and continues to revolve until the car stops. It is easy, by varying the position of the roller *l* in the direction of its axis, to adjust the rolling circle so that for a given diameter of wheel the counter records, in metres, the distance travelled. A micrometer screw is provided to correct for wear of tire.

#### Speed gauge.

The speed is measured by means of the Amsler speed gauge, already referred to above and shown in figures 2 to 4. In order to show clearly how this gauge works, we give a separate diagram of it (fig. 9). A steel sphere G is supported on three rollers  $R_1$ ,  $R_2$ , and  $R_3$ , so that it

can freely revolve about its centre of gravity. The axes of rotation of the two rollers  $R_1$  and  $R_2$  are perpendicular to each other and in the same plane as the centre of the sphere. The weight of the sphere is such that its adhesion to the rollers enables the latter to turn it without slipping. Roller  $R_1$  turns with a velocity proportional to that of the train; roller  $R_2$  turns at a uniform velocity. Roller  $R_3$  is supported in a light frame which can turn freely, so that, when the sphere turns, it takes the position in which the roller  $R_3$  can turn without slipping; that is to say, its axis of rotation at any moment is always parallel to the axis of rotation of the sphere.

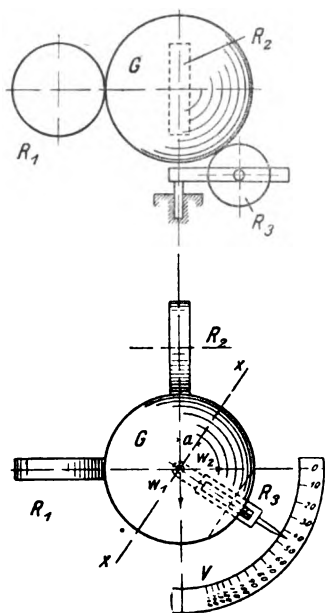


Fig. 9. — Speed gauge.

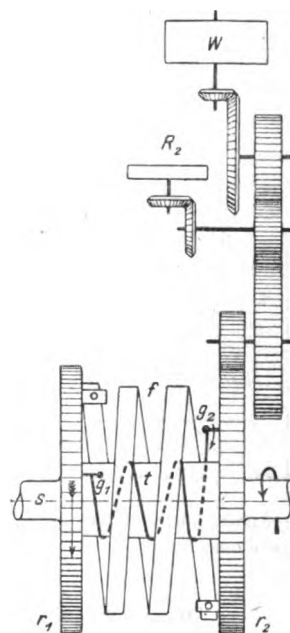


Fig. 10. — Spring gear.

If one only of the rollers  $R_1$  or  $R_2$  were to revolve, the axis of rotation of the sphere would be parallel to the axis of the roller in question. But as both rollers revolve simultaneously, this rotation takes place about an axis  $xx$ , which represents the resultant of the movements of the two rollers. If  $w_1$  and  $w_2$  are the angular velocities of the two rollers  $R_1$  and  $R_2$ , the angle  $\alpha$  which the axis of the rotation of sphere makes with the axis of the roller  $R_1$  is obtained from the equation

$$\tan \alpha = \frac{w_1}{w_2} = \frac{n_1}{n_2},$$

where  $n_1$  and  $n_2$  represent the number of revolutions of the rollers  $R_1$  and  $R_2$ . This equation is used to graduate the arc V; a pointer fixed to the frame shows the speed of running at any

given moment. A lever transmits the movements of this pointer to pencil 5 which traces the speed curve.

In the instrument in use (figs. 3 and 4) the roller  $R_3$  is replaced by two rollers placed exactly opposite each other in a revolving ring. The result is that the sphere is not disturbed by any vibrations.

### Spring driving gear.

In order to show how this acts, we give a diagrammatic sketch (fig. 10) of its working parts. A drum  $t$  is fixed to the main shaft  $s$ ; the wheels  $r_1$  and  $r_2$ , loose on shaft  $s$ , are connected by a helical spring  $f$ , coiled in one direction, and by a wire rope  $g_1, g_2$ , coiled in the opposite direction round the drum. The spring is adjusted so that its tension tends to move the two wheels in opposite directions, but the wire rope resists this tendency. If shaft  $s$  is turned in the direction of the arrow, the drum by the friction of the rope exercises a pull on  $g_1$  and this turns the wheel  $r_1$  and the tension on the spring is thereby gradually increased until it overcomes the resistance of the gearing actuated by the wheel  $r_2$ , gearing which is connected with the air fan  $W$ , the roller  $R_3$  of the speed gauge and the driving drum which pulls along the paper; and all these mechanisms then begin to work. The tension of the spring is regulated so that at a certain relative speed of the wheels  $r_1$  and  $r_2$  it counterbalances, at the exact speed desired, the resistance of the fan  $W$  and the other gears. The rope forms a sort of friction coupling which always keeps the spring at a uniform tension. If the shaft  $s$  revolves too quickly, then as the resistance of the vanes and of the gearing increases rapidly as the speed increases, the tension of the spring would increase for the moment and wheel  $r_1$  would advance relatively to wheel  $r_2$ ; but at the same time  $g_2$  would unroll the rope round the drum, and the rope would slip on the drum until the tension of the spring and the relative movement of the wheels were once more at their initial values.

In order to increase the speed of roller  $R_3$  and of the strip of paper, it is necessary to increase the tension of spring  $f$ . In order to facilitate this, and always have ready access to the rope, the rope and the spring are placed, in the existing instrument (*see* fig. 3), on two shafts  $s_1$  and  $s_2$  which are near to each other, and connected by the two pairs of pinions  $r_1, r_2, r_3$  and  $r_4$ . The working of the instrument remains unchanged by this modification.

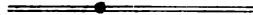
One of the ends of the spring  $f$  is connected with pinions  $r_3$  and  $o$ , the other with shaft  $s_2$ . This shaft is always kept in gear with the right wheel,  $r_2$ , which has ratchet teeth, by one of the two pawls  $p_1$  and  $p_2$ , which are placed with a half-tooth interval. If by means of a tommy placed in the holes of drum  $d$ , shaft  $s_2$  is turned relatively to pinion  $r_2$ , the tension of the spring is increased. In order to slack the spring, the pawl in action is pushed back, and then the spring turns back the pinion  $r_3$  relatively to the pinion  $r_2$  until the other pawl is engaged. This makes it easy to adjust the tension of the spring.

In order to make it possible to ascertain quickly whether the pinion  $o$  has the uniform speed required, the shaft  $s_2$  has a toothed wheel  $z$  with a pawl. The number of revolutions of this wheel and its teeth are so arranged that at the required speed the pawl gives 120 beats per minute.

Accordingly the rotation of the axle of the car is transmitted by the spring mechanism as follows. The bevel wheels  $q_1$  and  $q_2$ , mentioned above (*see* fig. 3), and a set of gear wheels turn the shaft  $s_1$  in the direction shown by the arrow. The wire rope by friction turns the pinion  $r_1$ , which turns the wheel  $r_2$ , and by means of the ratchet gear the shaft  $s_2$ . Then the spring

transmits the movement to the pinions  $r_1$ ,  $o$  and  $r_4$ . The rotary movement, which is by now uniform, is then transmitted by the pinions  $o$ ,  $w$  and  $n$  to the fan  $W$  and the roller  $R_2$ , through the toothed wheels  $r_4$ ,  $u$ ,  $v$ , and the corresponding gearing.

The different parts of the mechanism are all made very strong, so as to work perfectly even at high speeds. The whole apparatus has evidently been designed with the greatest care, and the many difficulties have been overcome with much ingenuity. But it would take us too long to consider all the details involved.



## THE GASOLINE CAR FOR INTERURBAN SERVICE <sup>(1)</sup>,

By F. W. HILD,

CHIEF ENGINEER, SOUTHWESTERN WISCONSIN RAILWAY, DUBUQUE, IOWA.

---

Figs. 1 and 2, pp. 1663 and 1668.

---

*(Engineering News.)*

---

In view of the present widespread interest in steam railroad circles in the self power-contained car as a means of meeting the increasingly severe competition of the electric roads, it may not be amiss to consider this type of car from the view point of the electric railway engineer.

That the large roads have keenly felt the electric railway competition has long been known and it is now particularly evidenced by the various methods under consideration for meeting it. Thus the Union Pacific has built at its Omaha shops a straight gasoline car, wherein the power output of a gasoline engine is mechanically transmitted to the car wheels. The Chicago, Burlington & Quincy some months ago built at its Aurora shops, and for a short time experimentally operated, a gasoline electric car, wherein the power output of the gasoline engine was transmitted electrically to the wheels. The Delaware & Hudson has placed in operation a gasoline electric car built by the General Electric Company. The Lake Shore is also trying such a type of car. The Ohio River & Columbus Railway, according to the technical press, is experimenting with a steam propelled car, which is to be a modern edition of the old time steam dummy. The press very recently described the Strang electric railway car a gasoline electric car which ran with its own power from Philadelphia, where it was built, to Kansas City, where it is to go into service on an interurban road in that vicinity.

The writer has seen experimental outfits utilizing the automobile principle of carrying the motive power on the truck frame. In one case it was a high pressure superheated steam engine with direct chain transmission and with flash boiler, kerosene or gasoline pan burner, radiating condenser, etc., all very much the same as the equipment of the well-known "White" steam automobile. In another case, it was a four-cylinder gasoline engine, with friction disk transmission, etc., similar to automobile equipment.

The independent motor car idea had its inception abroad, and much more work has been done in this direction in France, Germany and Great Britain than in this country. The most conspi-

---

(1) From a paper read before the Iowa Street and Interurban Railway Association.

cuous application of the idea is the steam motor cars of the Great Western Railway of Great Britain. This railway has in use a number of modernized steam dummy cars using coal as fuel for steam generation. The preference on the continent seems to be for the internal combustion engine and several experimental gasoline engine cars are being tried. The Wurtemberg Street Railway is one of the most persistent of foreign roads in trying the independent motor car. This railway has experimented with electric storage battery cars, with steam motor cars of the Serpollet type and gasoline cars of the Daimler motor type. It is interesting to note that the Wurtemberg Street Railway put an independent gasoline motor car into service in December, 1893, something over twelve years ago.

There can be no doubt that most of the several types of self power-contained cars, will find useful fields of application and will become valuable auxiliaries to the standard forms of rail transportation; but also, in the judgment of the writer, there should be no doubt that these fields of application will be relatively restricted and do not include such as are now served by the standard electric system.

The factors which have made electric traction so brilliantly successful in city, urban and inter-urban service are many and varied, but those which enter into a discussion involving a consideration of other types of motor cars are :

- a) Reliability and simplicity;
- b) High schedule speeds and high train frequency;
- c) Cleanly and noiseless operation;
- d) Low cost of operation and of maintenance.

On the other hand, the self powered cars enjoy two advantages which are the sole reasons for the present interest in this type of car. They are :

- e) Absence of external power transmission circuits;
- f) Lesser initial investments.

It is the purpose of this paper to briefly investigate and compare these several factors.

### **Descriptive.**

The straight electric system has been in use some seventeen to eighteen years, and its essential features of power-station, substation, transmission line, overhead or third-rail conductor, track return circuit, trolley and car equipments, are well understood by all railway men. The several types of independent power-contained cars have been described at different times in the technical press.

Apparently, the greatest difficulty encountered by the designers of the gasoline cars is the transmission of power from the engine to the driving wheel. This is not surprising in view of the fact that the internal combustion engine is essentially a constant speed motor, and that railway work demands wide ranges of variable speeds. At the present time, the favorite means appears to be the use of electricity, indicating that the difficulties of direct mechanical transmission and variable speed operation are so great as to warrant the rather roundabout transmission involved by the addition of generator, with or without batteries, and the standard railway type motors and control. Indeed it is claimed by the promoters that the efficiency of the gasoline electric outfits compares very favorably with any type of mechanical transmission and moreover, has the greater advantages of large variations of speed, flexible driving, ease of control, and lesser wear

and tear. The acceleration and changes of speed are smooth, and without the jar or shock which is ever present with any mechanical change-speed gear. This situation suggests to electrical engineers the early discussions of series vs. shunt motors for railway work. The designers of the gasoline-electric cars, while fully agreed as to the method of power application, nevertheless differ among themselves on the important question of power supply — thus some insist that a storage battery is an indispensable adjunct, for the reason that gasoline engines have low efficiencies at fractional loads and furthermore have practically no overload margin; the battery, therefore, is needed to take care of the recurring inevitable overloads. Others, however, prefer to use a much larger generating unit, largely because of the saving in weight and space, and the avoidance of acids and fumes.

#### General comparison.

*Reliability.* — It probably needs no argument to show that the straight electric car considered alone, is far less complicated and hence far more reliable than any other form of motor car. The straight electric has the minimum of moving parts, all of which (excepting the brake mechanism, which are common to all cars) are non-reciprocating, while all other types of self-propelled cars have reciprocating mechanisms, which include a great number of moving parts, more or less complicated in adjustment. The greater simplicity and reliability of the standard electric car is perfectly obvious in the fact that, aside from the conductor or fare collector, but one attendant, the motorman, is necessary for the car operation, whereas, every type of independent railway motor car, so far as the writer knows, requires an additional skilled mechanic to look after the portable power plant. Of course efforts are and will be made to render the equipment so thoroughly automatic as to permit the dispensation of this skilled mechanic. Far be it from the writer's wish to infer that American inventive ingenuity may not accomplish this, but a few healthy doubts as to its early attainment are permissible, when one remembers the automobile enthusiast who stated that he owned a car for three years, of which he spent one year on it and the other two under it. The annoyances which may attend the use of a private vehicle may be tolerated by the owner, but such annoyances would be prohibitive in a public utility like a transportation system, therefore, the need of minimizing interruptions and delays will undoubtedly compel the retention of the extra attendant.

But the question of reliability of the straight electric goes beyond the car itself, and involves a consideration of power generation and transmission. Power generating machinery, both steam and electric, has been brought to a very high order of development, and in the hands of thoroughly competent operators, the probability of interruption of power service through failure of this machinery is extremely remote, particularly if the plant be provided with a judicious, yet reasonable, reserve. There are plants in this country which have operated for years without failing to deliver power, and it has come to be understood that the engineer who fails to "keep the busses hot" must have an exceptionally good excuse in order to retain his job.

The power transmission to the cars is by conductors running parallel to the track, generally carried overhead, sometimes close to the track, as on third-rail roads, and sometimes under the track as on slotted conduit roads. Where converter substations are in use for changing the generated electric power to different voltages or kind of current, "power transmission" includes high tension conductors which are carried in the form of multiple conductor cables underground, or as separate conductors overhead on poles.

In the earlier days, the power transmission did not receive the attention of designing and con-

struction engineers so much as the power machinery, and in consequence, there were many troubles with the earlier transmission circuits. These earlier experiences served to give the power transmission system a reputation for weakness, which was never fully deserved and which now no longer obtains. The modern transmission circuit, whether for alternating or direct currents is of sturdy construction, mechanically strong and reliable, so that the percentage of failures due to all causes, except the elements, is no greater and usually less than experienced with other parts of the roadway.

The elements, however, introduce difficulties into power transmission of the overhead variety, which have at times been the cause of provoking interruption to service, but at the extreme, such interruptions are nothing worse than brief temporary stoppage of the cars, and are not accompanied by the fatal disasters consequent to the broken track rail, the misplaced switch, the defective or storm weakened bridge, or the faulty signal. The heavy substantial construction of modern transmission and overhead conductor systems, enables them to withstand the ravages of storms very successfully, more so than the present telegraph, telephone and signal transmission systems, and it is not unusual to hear of electric roads maintaining service during storms that tie up the steam roads. The greatest source of disturbance to power transmission systems is lightning. Considerable progress has been made, in recent years, through careful study and experiment by leading engineers, in the development of adequate means for protecting electrical apparatus against lightning. As a result, protective devices are now available which limit interruptions to service to such a point that the transmission circuit given proper and reasonable attention is fully as reliable in every respect as any other part of the railway system.

#### **Schedule speeds and train frequency.**

It is a peculiar fact that no other form of machinery, whether used for power generation, power translation, or power utilization, has such high efficiency, such capacity for overload and such flexibility of control as has electrical apparatus. The remarkable speed-and-torque characteristic of the series-wound motor, permits of a smooth and rapid rate of acceleration, absolutely under the control of the operator. This rate of acceleration may be practically anything desired, and is accomplished without resorting to excessive power demand or abnormally large motors. The maximum acceleration is usually determined by the comfort of the passengers, and by the slipping of the wheels, and is not limited by energy consumption. Indeed, it has been shown that for a given schedule the equipment having the highest rate of acceleration will perform the service with the least energy consumption.

The facility for maximum acceleration, the great capacity for overload, and the high ratio of power to weight, enable the straight electric car to handle successfully and economically higher schedule speeds than any other type of car, no matter how equipped. The steam engine operated car, because of the overload power of the steam engine, would probably come next, while the gasoline car, with direct mechanical transmission would, because of the absence of starting torque and of overload capacity of the gasoline engine, fall well below them all.

High accelerating power becomes more important as the number of stops in a given distance increase, and it is this fact, as well as the difficulty of mechanically transmitting power from the gasoline engine to the drivers, which renders combination gasoline electric cars at present the most promising of the self-contained cars.

That system of transportation operating the most frequent trains, will obviously best serve the travelling public. The experience with the standard electric cars has demonstrated the public's

appreciation of this in the new business which the electricians have built up for themselves. Such frequent train service of the standard electric system is made possible by the fact that practically no power is wasted. The motorman, by the simple manipulation of his controller, utilizes the power only as it is needed, and does not waste energy — that is fuel — when the train is coasting or standing still. Experience of electric roads is such that the starting and stopping of the different train units so dovetail into one another, that the load on the central power house is proportional to the average energy consumption per train.

Any system of transportation employing self-contained motive power units, must be obviously at a disadvantage in this respect, since fuel consumption must go on all the time the train is in service, whether it is coasting or standing at a station.

#### **Cleanly and noiseless operation.**

The great importance of cleanly and noiseless operation of trains, is best evidenced by the action of the New York Central, the New York, New Haven & Hartford, the Pennsylvania, the Long Island Railroad and the Baltimore & Ohio, in electrifying their largest terminals. It is well known that this action was largely brought about by public sentiment. That the builders of self-contained cars appreciate the importance at least of cleanliness is indicated by the fact that nearly all are using oil for fuel, and practically none of them would consider the smoke, cinder and soot producing fuels such as coal, etc. The advantages, if any, are in favor of the standard electric system, for there must always be present some vibration and some exhaust fumes from the engine of the self-powered car.

#### **Operating and maintenance costs.**

The absence of actual operating data of self-contained cars does not permit, at the present time, of a comparison of actual maintenance and operating charges between such cars and the straight electric. It is perfectly logical, however, to expect in view of the complicated mechanism of the former and extreme simplicity of the latter, that the *maintenance charges* for the self-contained car system, will be greater than for the straight electric. The maintenance cost may reasonably be expected to be about midway between the electric car and the steam locomotive.

The *operating cost* of the several types of self-contained cars, will naturally vary among themselves, but in all instances, such costs exclusive of interest on the investments, will be materially higher than the straight electric, and in most cases, the costs, including interest charges, will favor the straight electric.

This reasonably follows in view of the high efficiency of the modern power station and transmission systems of electric traction, and also because of the high weight efficiency of electric cars. The independent motor car must not only drag along its own power plant, but it must sacrifice valuable remunerative space in order to carry it. For the same remunerative capacity, the self contained car will weigh from 50 to 100 per cent more than the standard electric car. Under the same conditions of track, speed and distance, the energy consumption required to move cars of any sort will vary as their weight, whence it follows that the energy consumption of the self-contained car will be from 50 to 100 per cent greater than the electric car.

The labor expense of practically all types of self-contained cars will be 50 per cent and upwards greater than the straight electric for the reason that, in addition to motorman and the conductor, a skilled mechanic is necessary for the operation of the power generating apparatus

in each of the self-contained cars. This attendant is usually paid 30 to 40 cents per hour, or from 50 to 100 per cent higher wages than the ordinary platform man receives.

All self-contained cars, excepting those equipped with storage batteries, must have prime movers of sufficient capacity to suitably accelerate the cars, and since the power required for accelerating is from two to four times that for full speed running, and also because of the intermittent power demand in railway service, it follows that the average load on the prime mover will be but a fraction of its rated power; hence the efficiency of engine operation, whether steam or gasoline, must be low. This condition is worse with gasoline engines, which have no overload margin, and in many cases, the average load will probably not exceed 40 per cent. Where floating storage battery is carried on the car it is, of course, possible to use a smaller engine and to work it at close to its rating most of the time, and the fuel cost per ton mile of such a car would be somewhat less than of one without battery.

The St. Joseph Valley locomotives with single trailer, during the early days of its operation averaging 66 miles per day consumed 50 gallons of gasoline per day. This worked out per train mile as follows :

Fuel at 16 cents per gallon . . . . .	12.0 cents.
Labor, 75 cents per hour . . . . .	3.4 —
Acid, water, waste, sundries . . . . .	0.6 —
	<hr/>
	16.0 cents.

Mr. H. M. Beardsley published in the *Street Railway Journal*, July 15, 1905, a very complete table of operating statistics of electric roads in New York State. A study of this shows that straight electric operation per car mile is much less than the above figures, and if the comparison be made on the basis of cost per car seat, or unit of remunerative space, the showing will be still more in favor of the straight electric cars. The averages of ten roads in the table work out as follows :

OPERATION.	
Power . . . . .	2.629 cents.
Wages of conductor, motorman. . . . .	4.146 —
Car service supplies . . . . .	0.109 —
Miscellaneous . . . . .	0.16 —
	<hr/>
	7.044 cents.

Comparison between a single concrete case and an average of a lot of widely varying cases while giving an indication is not convincing, it may be of more interest therefore, to compare briefly the requirements and performance of a gasoline electric car, and a straight electric car for transporting a given number of passengers, under the same conditions of distance, time, stops and roadway. Assume a line 25 miles long, standard steam railroad construction, stops of 15 seconds' duration each, to average one every three miles. It is desired to operate a car seating 48 passengers, making the run one way in one hour.

Let us take the Delaware & Hudson car previously mentioned. It has been recently described in the technical press, but no hint of its detailed performance is published, so we must rely upon calculated performance. This car weighs about 125,000 lb., and the car body, 65 feet over all, is of the combination type, that is, with passenger and smoking compartments, seating a total of 40 passengers and with baggage express compartment. The engine is at one end, and the

motorman's compartments with controlling apparatus at each end for operation of the car in both directions. Power is supplied by a 160 horse-power gasoline engine, directly connected to a 120-kilowatt separately excited generator. A small 5-kilowatt generator furnishes the excitation. The motor equipment consists of two 200 horse-power each, standard railway motors, with two series parallel controllers. The generator output is limited by the capacity of the gasoline engine. The controllers, besides the usual connections for changing motors from series to parallel, also have connections for changing the voltage of the generator through its excitation. The acceleration and speed regulation of the car is then governed by the voltage of the generator and not by the usual method of resistance in series with the motors.

A standard interurban car, about 45 feet long, will seat comfortably 48 passengers, and will weigh fully equipped 24 to 28 tons. With four 50 horse-power motors geared to about 35 to 38 miles per hour, maximum speed, and with normal trolley voltage, such a car will perform very satisfactorily the service outlined.

In figure 1 are two curves, showing the schedule performance, which might be expected of the two cars — B referring to the gasoline electric car, and A to the standard interurban car. Incidentally, it is interesting to observe that as the frequency of stops increases, the self-contained car falls much more rapidly away from the schedule than the straight electric. Thus, at one stop per mile it can do 18  $\frac{3}{4}$  miles per hour schedule, while the straight electric can do 21  $\frac{3}{4}$  miles per hour.

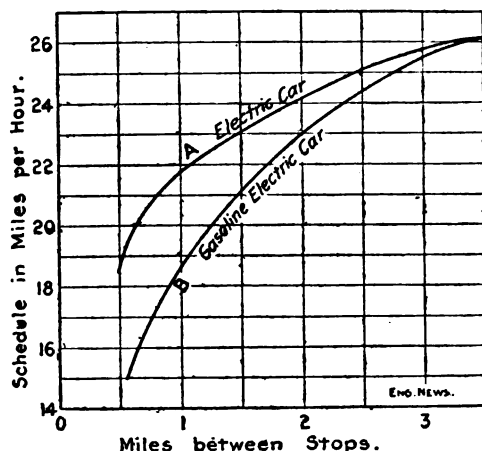


Fig. 1. — Comparison of probable speed of standard electric car and gasoline electric car.

Under the conditions assumed, the rate of energy consumption of the straight electric car will be about 60 watt hours per ton mile, at the motors, and this value will be used as applying to the combination self-powered car, although as a matter of fact, the input to the latter will be somewhat higher owing to its slower rate of acceleration, and would more than offset the elimination of rheostatic losses in the motor control.

Manufacturers of gasoline engines of the size under consideration, generally claim 10 horse-power-hours output per gallon of gasoline at full load, but will guarantee only 8 horse-power-hours per gallon of this fuel. In the calculations which follow, no account will be taken of the

rapid falling off in fuel economy at fractional loads, so in using the 8 horse-power hours per gallon value, the error, if any, is in favor of the gasoline outfit.

Electric power station performance is well known from numerous published or otherwise available records. The following is typical of a 4,000-kilowatt turbine, water-tube boiler plant with coal at \$1.60 to \$1.80 per ton.

Coal. . . . .	\$0.0034
Labor . . . . .	0.0016
Maintenance . . . . .	0.0007
Supplies . . . . .	0.0003
Cost per kilowatt hour at switchboard. . . . .	\$0.006

A well operated plant with fairly good load factor should encounter little difficulty in producing power at this figure; indeed, many show much better results. For the purposes of this discussion, however, a higher figure — \$0.0085 — will be taken. This value is easily attained by most of the interurban power plants in the Middle West.

Transmission efficiencies to the motors will be taken to average as follows :

	A. C. system.	D. C. system.
Step-up transformers . . . . .	96 per cent.	96 per cent.
Line. . . . .	97 —	97 —
Step-down transformer . . . . .	96 —	96 —
Rotary . . . . .	... —	88 —
Car transformer . . . . .	96 —	... —
Feeder and trolley net work . . . . .	93 1/2 —	89 —
Net efficiency. . . . .	80 per cent.	70 per cent.

*Gasoline electric car 62 1/2 tons.*

$$62 \frac{1}{2} \times 60 = 3.75 \text{ kilowatt-hours per car mile.}$$

$$3.75 \times 25 = 94 \text{ kilowatts average per trip.}$$

94 kilowatts = 78 per cent of 120 kilowatts the rating of the generator and at this average load, generator efficiency equals 90 per cent approximately.

$$\text{Then } \frac{3.75}{0.746 \times 90} = 5.6 \text{ horse-power-hours per car mile.}$$

The engine will develop at full load about 8 horse-power-hours per gallon of gasoline.

With fuel at 10 cents per gallon.

$$\text{Power } \frac{10 \times 5.6}{8} = 7 \text{ cents per car mile.}$$

*Car crew.*

Motorman . . . . .	0.21 per hour.
Conductor. . . . .	0.21 —
Mechanic. . . . .	0.33 —
	0.75 per hour.

$$\frac{75}{25} = 3 \text{ cents per car mile.}$$

Waste, oil, small supplies . . . . . 0.60

*Straight electric car 30 tons.*

$30 \times 60 = 1.80$  kilowatt-hours per car mile.

$1.80 \times 25 = 45$  kilowatts average per trip.

Power at interurban generating station costs \$0.0085 per kilowatt-hour at the busses; taking transmission efficiency to the motors at 80 per cent (A. C. system).

Then  $\frac{1.80 \times 0.0085}{80} = 1.91$  per car mile.

*Car crew.*

Motorman . . . . .	0.21 per hour.
Conductor . . . . .	0.21 —
	<hr/> 0.42 per hour.

$\frac{42}{25} = 1.68.$

Allow for substation attendance. . . . .	0.01
	<hr/> 1.69 per car mile.

Waste, oil, small supplies . . . . .	0.55
--------------------------------------	------

**SUMMARY.**

7.00 . . . . .	Power . . . . .	1.91
3 . . . . .	Labor . . . . .	1.69
0.6 . . . . .	Supplies . . . . .	0.55
<hr/> 10.60 . . . . .	Per car mile . . . . .	<hr/> 4.15

These are comparative costs per car mile, exclusive of maintenance and of general expense, and are subject to considerable variation under varying conditions. The Union Pacific car, which weighs about 29 tons, has unofficially been stated to consume  $\frac{1}{2}$  gallon gasoline per car mile in service, involving much fewer stops. The Strang gasoline storage battery car, weighing approximately 37 tons, consumes, according to official statements of the builders,  $\frac{45}{100}$  gallon gasoline per car mile. No statement of service conditions is given, but it is inferentially taken from the run from Philadelphia to Kansas City, where the stops were very infrequent, probably less than 1 in 20 miles.

As a check on the above calculations, this data is interesting. The gasoline consumption per ton mile works about as follows :

D. and H. car . . . . .	0.0112 gallon.
U. P. car . . . . .	0.0168 —
Strang car . . . . .	0.0118 —

It is not intended to compare these three types of independent motor cars, for such comparison would be manifestly unfair, unless one took into account all the factors entering into the construction and operation of each of the cars. It is intended to show, however, that the calculated performance of the D. & H. car includes a margin favoring the independent motor car as compared with the standard electric.

### Initial investments.

To get down to the gist of the whole problem and to see the influence of the initial investments on a given proposition, we will investigate two cases; the first between the gasoline electric and the standard electric, and the second between these and steam railway service.

The first proposition contemplates the average interurban condition, and may represent, if you will, the competition between two parallel roads for the local passenger and light traffic business, which is assumed to demand cars at one hour headway from 6 a. m. until 12 p. m., or 18 hours' service. The items of cost and maintenance common to both roads, will not enter into the present consideration, and we will assume that the general expense of administration, engineering, taxes, insurance, etc., will be the same in both. We will take the same service conditions as before, *i. e.*, 25 miles of road, stops every 3 miles and 1 hour for the run.

The single-phase system is well adapted to such service, and will be considered in the following. It would be entirely feasible to operate with a generating plant in the center of the line feeding 6,600 volts directly into the trolley, eliminating high tension transmission and substation and thereby effect a saving in the assumed case of approximately \$18,000. But it might be necessary because of water supply, coal, etc., to build the power house at one end of the line and thus necessitate a substation. In order to be entirely fair to the gasoline car, let us assume this extreme condition.

Two cars will normally handle the service, but for special days requiring half hour headway and for reserve, four motor cars and two trailers will be purchased. The normal daily mileage will be 900.

#### *Estimated cost of straight electric system.*

Power plant . . . . .	\$ 45,000
One substation . . . . .	2,000
Distribution system . . . . .	48,000
Four motor cars } . . . . .	36,000
Two trailers }	
Rail bonding . . . . .	6,250
	<hr/>
	\$ 137,250
Interest and depreciation at 10 per cent . . . . .	13,725
	or, \$ 37.60 per day.

#### *Estimated cost of gasoline electric system.*

Four motor cars @ \$17,000 . . . . .	\$ 68,000
Two trailers @ 3,000 . . . . .	6,000
	<hr/>
	\$ 74,000
Interest and depreciation at 10 per cent . . . . .	7,400
	or, \$ 20.30 per day.

The maintenance of electric cars and plants per car mile, can be assessed fairly well from the many published records, but that of the self-powered cars is, at present, a matter of guess. It will be taken at 4 cents per car mile, which is, roughly, one-half the average maintenance charges of steam locomotives per mile.

	Gasoline electric.	Standard electric.
Power . . . . .	7.0	1.91
Car crews . . . . .	3.0	1.68
Supplies . . . . .	0.6	0.55
Maintenance equipment and cars . . . . .	4.0	1.5
Maintenance plant and distribution system . . . . .	...	0.5
Operating cost per car mile . . . . .	<u>14.6</u>	<u>6.05</u>
Daily cost.		
Operation . . . . .	\$131.40	\$54.45
Interest and depreciation . . . . .	<u>20.30</u>	<u>37.60</u>
	\$151.70	\$92.05

Thus, the difference in favor of the straight electric under the conditions assumed, would be \$59.65 per day or approximately \$22,000 per year.

Consider now, an existing branch of a steam road, where the passenger traffic is light. Service must be given even if without profit, indeed many such branch lines are now operated at a loss, so far as the passenger and light traffic is concerned. The problem then is to find the cheapest means of handling the business.

Let us take the same length of line, frequency of stops, etc., as before, but that four trains each way per day will handle the business. We will assume that the train crews when not on the passenger runs are kept employed elsewhere on the system. The steam service would call for two light locomotives and four passenger combination cars. The self-powered and the straight electric would each require two motor cars and two trailers. The trailers would not be used during the normal service, but would have to be purchased and kept to meet the demands of Sundays and special days.

It is assumed that the roundhouse, repair shop and water tanks would about balance the cost of electric car barn and repair shop. Omitting, then, as before, all factors of cost and operation common to all three systems, we will have :

*Estimated investment for steam service.*

Two 45-ton locomotives with tenders . . . . .	\$16,000
Four passenger coaches . . . . .	<u>16,000</u>
	\$32,000
Interest and depreciation at 10 per cent . . . . .	3,200
or, \$8.78 per day.	

*Estimated investment for straight electric service.*

Power plant . . . . .	\$27,000
Substations . . . . .	1,500
Distribution system . . . . .	48,000
Two motor cars } . . . . .	21,000
Two trailers }	
Rail bonding . . . . .	<u>6,250</u>
	\$103,750
Interest and depreciation at 10 per cent. . . . .	10,375
or, \$28.50 per day.	

A plant of this size would not produce power so cheaply as the larger ones previously considered. The cost per kilowatt-hour is taken at 1 1/2 cent per kilowatt-hour, whence we have :

Power . . . . .	3.38 cents per car mile.
Labor (as before) . . . . .	1.69 — — —
Supplies (as before) . . . . .	0.55 — — —
Maintenance (as before) . . . . .	2.00 — — —
<hr/>	
	7.62 cents per car mile.

*Estimated investment gasoline electric service.*

Two gasoline electric cars . . . . .	\$34,000
Two trailers . . . . .	6,000
<hr/>	
	\$40,000
Interest and depreciation at 10 per cent . . . . .	4,000
or, \$10.90 per day.	

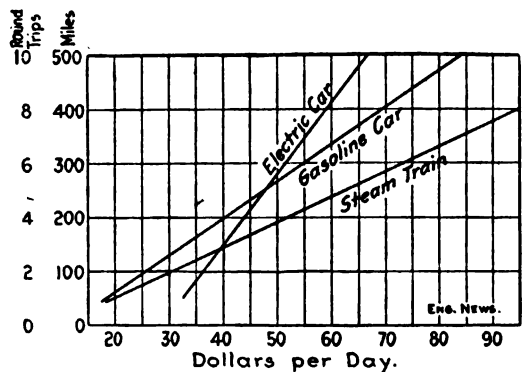


Fig. 2. — Comparative operating cost of steam, locomotive, electric and gasoline systems of passenger transportation.

The steam train will consist of the locomotive, tender and two cars, giving a train weight of approximately 110 tons; under the assumed conditions of schedule, stops, weight, etc., such trains will require about 35 watt-hours per ton mile, i. e., 0.0745 horse-power per ton mile. In such service, the locomotive would burn about 7 lb. of coal per horse-power-hour, and if this coal cost \$2.25 per ton, the train mile cost would be approximately :

*Train crew.*

Engineer . . . . .	0.35 per hour.
Fireman . . . . .	0.21 —
Conductor . . . . .	0.30 —
Brakeman . . . . .	0.175 —
<hr/>	
	\$1.035 per hour.

Power . . . . .	6.35 cents per train mile.		
Maintenance locomotive and cars . . . . .	8.00	—	—
Supplies . . . . .	2.00	—	—
Round house exp. . . . .	1.00	—	—
Train crew . . . . .	4.15	—	—
	<hr/>		
	21.5	cents per train mile.	

The daily operating costs, exclusive of those items which are common to all the systems, would then be :

	Steam.	Electric.	Gasoline.
Operation . . . . .	\$43.00	\$15.34	\$29.20
Interest and depreciation . . . . .	8.78	28.50	10.00
	<hr/>		
Total . . . . .	\$51.78	\$43.74	\$40.10

As the same equipment, and, therefore, the same investment, would be needed for a few trips more or less, and applying the same unit operating costs per car mile and the same fixed charges, we get the following :

Daily round trips.	Mileage.	Steam.	Electric.	Gasoline.
Six . . . . .	300	\$73.29	\$51.36	\$54.70
Five . . . . .	250	62.53	47.55	47.40
Four . . . . .	200	51.78	43.74	40.10
Three . . . . .	150	41.03	39.93	32.80
Two . . . . .	100	30.28	36.12	25.50
One . . . . .	50	19.53	32.31	18.20

This brings out clearly, that in the assumed case, the gasoline car is cheapest under six round trips per day, while the electric system is the cheapest at six trips or more per day.

Generally speaking, the gasoline car will show a saving over the steam train in light, infrequent service, but when the frequency begins to approximate 2 1/2-hour headway between trains, the electric car is undoubtedly the cheapest and becomes increasingly so with increase of traffic frequency.

#### External transmission circuits.

We come now to what probably more than any other factor, including even higher initial investment, has been the greatest stumbling block to the electrification of steam railroads. All other details of electric railroading have easily surmounted the objection of the steam railroad men; it is not the purpose to discuss the important subject of external transmission circuits within the limits of this paper, but it is well to point out that the progressive men in heavy railroad work, no longer look upon the electrical power conductor with the doubt and misgiving, not to say scorn, with which they regarded it a few years ago. The overhead trolley has demonstrated its reliability and sturdiness on thousands of miles of electric roads from Maine to California, from the Lakes to the Gulf, in all conditions of weather and seasons. But only very recently, low trolley voltage limited its use to light interurban service. The writer is quite in sympathy with the railroad men's objection to the third rail, which, while it has splendidly performed its functions of showing the possibilities of heavy traction — is for many reasons

inadvisable for surface work, although well adapted for subway or elevated roads. The advent of the single-phase system, permitting the use of high trolley voltages, and hence moderate power conductors and bow trolleys, has brought the overhead trolley conductor into the field of heavy railroading, and with the large Eastern roads setting the pace the early electrification of the present steam lines will inevitably come on.

### Conclusion.

Managers of steam railroads entrusted with the direction of large vested interests, are naturally very conservative and therefore slow to make what would appear to be radical changes in their equipment. Therefore, while they realize the limitations of the steam locomotive in suburban and interurban service, they will, before stringing the trolley wire over their tracks, try out pretty thoroughly the independent motor car, which holds out alluringly the suggestions of interurban service without the power-house, without the track bonding and without the external transmission circuit. This try-out will definitely establish the true field of the self-contained car, and in the writer's judgment, this field will be the very short spurs of existing steam railroads, serving sparse population, making infrequent trips principally to connect with main lines. Take one road — the Burlington for example; the Galena Junction shuttle train operating on a five-mile spur, and meeting the more important trains of the main line; and the Dubuque shuttle train which operates on the mile and a quarter spur from East Dubuque over the Mississippi River Bridge — these could well use such independent motor cars; unless, indeed, electric power at satisfactory rates can be purchased of the neighboring electric companies.

There is another field, not very wide it is true, but a profitable field which the independent motor car may enjoy with freedom from competition. The writer expects to see the present private cars of our millionnaires displaced by the independent motor car, which can be made as comfortable and luxurious as any of the Pullmans now in service. Their owners may go anywhere that standard gage tracks lead to, regardless of limitations to locomotives or to electric cars.

As to prospective interurban roads which are promoted with the view to using the gasoline or other types of independent motor, it is highly desirable to go slow and investigate. Broadly speaking, if a prospective road is to depend for revenue only on its passenger and light express traffic, and the business only warrants 1  $\frac{1}{2}$  or more hours headway between cars, it becomes very much of a question whether or not the road will pay or ought to be built at all.

But this brings us into the realm of interurban railway economics, concerning which much less even than railway engineering it is not well to generalize. Each individual proposition should be independently examined and passed upon by a competent engineer, who should determine the equipment best fitted for it.

In city service, the independent gasoline car will find only the remotest application. Under certain conditions of power, plant arrangement and operation, there may be isolated instances where the independent car might be called upon to handle the "Owl" service in the small hours of the morning. It may also be used on streets on which the municipality prohibits the laying of tracks. Indeed, such cars are already in operation on Fifth Avenue, New York. In such service, the independent car will probably displace the so-called "trackless" trolley cars, which are in use in some of the European cities.

In conclusion, the writer believes that the independent motor car will prove a useful trans-

portation medium. Its field will be distinct from that served by the standard electric system. The likelihood of the independent motor cars becoming serious competitors of the electric cars is quite remote. Reduction in operating cost of the independent car must come about through cheaper fuel and smaller labor expense. As we all know, the price of gasoline is constantly increasing, due to the diminishing supply of the crude oil from which it is made. Kerosene engines and alcohol engines are frequently spoken of, but as yet can not compete with the gasoline engines. The reduction in labor expense is not very promising. Advances and improvement in the art of independent motor car will undoubtedly be made, but at the same time, it must be borne in mind that the electric system will by no means stand still, and if its future progress be judged by that of the past, it will undoubtedly become the preeminent transportation medium.

---

## RECENT HIGH-SPEED TRIALS OF STEAM LOCOMOTIVES.

(*Zeitung des Vereins.*)

The favourable results of the high speed trials of steam locomotives, made in 1904, by order of the Prussian Minister of Public Works, on the *Militärbahn*, made it possible to draw conclusions as to what modern locomotives are capable of in the way of initial pull and acceleration. Moreover, the trials showed what influences the locomotives and the cars were exposed to at high speeds. But they could not show how the rolling stock, and more especially the locomotives, would behave during long high-speed runs, or what the economic results of a regular high-speed service would be. It is clear that the latter problem can be approximately solved only by trial runs over long distances, with intermediate stops. As supplementary to the trials on the *Militärbahn*, trials were accordingly made last year with steam locomotives running a much longer distance, the trial runs being interpolated in the regular service. Mr. Leitzmann, member of the Board of Works, has published a detailed report of these recent trials; we extract sundry particulars of general interest, which supplement the results of the high-speed trials made previously, and indicate in what ways not only rolling stock, but also railways as a whole, should be improved.

The trial runs in question were made on the Hanover-Spandau line, 243·5 kilometres (151·3 miles) long; there are curves of 750 metre (37  $\frac{1}{2}$  chain) radius near Hanover, Lehrte and Spandau, whereas the radii of the other curves are between 1,000 and 3,766 metres (between 50 and 188·3 chains). Moreover, the profile is a favourable one and the steepest gradients do not exceed 3·3 per mil. In accordance with the instructions issued, two sets of speed trials were arranged. In the first, the train was to consist of 40 axles, and to run at 100 kilometres (62·1 miles) per hour; in the second, of 20 axles, to run at 120 kilometres (74·6 miles) per hour. The latter train was, however, to run at a higher speed, up to 140 kilometres (87 miles) per hour, over certain sections of the line. Unfortunately however, it was impossible to carry out this programme in its entirety, as the nature of the line on which the trials took place, imposed certain limitations of speed. Thus the speed through Lehrte station might not exceed 40 kilometres (24·8 miles) per hour, and through Isenbüttel, Oebisfelde and Schönhausen, 90 kilometres (55·9 miles) per hour; and then on the bridge over the Elbe, near Hämerten, speed was limited to 60 kilometres (37·3 miles) per hour. On the return journey moreover, there were two sections, between Spandau and Stendal, which were under repair and where speed had consequently to be reduced. Nevertheless, there were sections where the specified speed could be kept up during at least ten minutes, whereas in the trials on the *Militärbahn* a uniform speed had not even been attained.

The track was not altered in any way before the trials took place. The greater part of it is laid with rails weighing 41 or 43·4 kilograms per metre (82·7 or 87·5 lb. per yard), but there are sections where the rails weigh 33·4 kilograms per metre (67·3 lb. per yard). The sleepers are of oak, pine and iron, bedded on a ballast of broken stone or gravel. The track as a whole, is thus lighter than that of the *Militärbahn*, which had been strengthened for the high-speed electric trials. The track on this Hanover line was so little affected by the high-speed trials, that no repairs were necessary after they were over; the inference may be drawn that in Germany the track is stronger than is generally thought, and that the type of track now adopted on main lines is quite good enough for speeds exceeding 90 kilometres (55·9 miles) per hour, and for a high-speed service. It seems, on the contrary, doubtful whether any further stiffening of the track is conducive to the smoother running of the trains <sup>(4)</sup>. The superelevation now given is also sufficient for the purposes of a high-speed service.

On the other hand, the supervision of the track and the safety and signalling appliances require further improvement. Brake trials have shown that at a speed of 130 kilometres (80·8 miles) per hour, with a brake efficiency of 100 per cent, the train does not stop, after the brakes have been applied, till it has run about 1,400 metres (1,500 yards). Now this is a longer distance than that at present adopted between the distant and the home signals. The brake trials carried out in connection with the high-speed trials on the *Militärbahn*, had already shown that special precautions were required in this connection in the case of high-speed runs. As in the case that we are considering, the line could not be monopolized for the trials (as it could in the *Militärbahn* trials), but had also to be used for the regular service, and as it was difficult, owing to its length, to keep the whole line clear during the trials, it was necessary, in order to avoid accidents, to issue very strict and definite instructions to all the line and station employees.

Three different locomotives were used to haul the trial trains; as already stated one of these had 40 axles and the other 20. The trains consisted of AB, ABC and C cars, which were carefully greased and coupled up as the regulations direct. The 40-axle train weighed 317·92 tons (312·90 English tons), the 20-axle train 156·40 tons (153·93 English tons). Altogether twenty trial runs were made, three of which were of locomotives alone, in order to see how they behaved at high speeds. It was found that although the time-tables which had been drawn up could be kept as far as the total time for the run was concerned, it was not possible to attain the speed of 140 kilometres (87 miles) per hour, even when the train only consisted of 20 axles, in the first place because the locomotive power available was not sufficient between the successive slacks, secondly because two of the locomotives used began to be very unsteady already at 120 kilometres (74·6 miles) per hour. Among the seventeen other trial runs, there are some which are not suitable for comparative purposes, because exact data could not be obtained owing to delays, slacks or sundry other incidents. For the comparison proper, only six runs are available: one with 40 axles and one with 20 axles, with each of the three locomotives.

The locomotives which belonged to the Hanover, Cologne and Elberfeld managements respectively, could be prepared but little for the trial runs, for time was short and the locomotives belonging to the Cologne and Elberfeld managements could only be lent for a few days. The

---

<sup>(4)</sup> It is quite possible that the last word on this point has not yet been uttered. We would remind our readers that before stiffer tracks were adopted, what is now said about the latter was then said about the 33·4 kilogram (67·3 lb. per yard) rail. Theory will not enable us to decide this point, but only extended experiments, such as are at present being carried out with heavier rails. (Note by the editor of the *Zeitung*.)

locomotive of the Hanover management was a four-cylinder compound, of the 4-4-2 type. As it was built by the Hanover Maschinenbau Company (successors to Egestorff) at Linden near Hanover, and had been delivered in November 1903, it had already done a fair amount of work; it had run 51,500 kilometres (32,000 miles). Although it had during this period been used continually for severe work, it was still, of the three locomotives used in these trials, the one in best condition. It was only during the last trial run, when exceptionally heavy work was being done, that some of the smoke tubes began to leak. The Cologne locomotive was also a four-cylinder compound, of the 4-4-2 type. It was built at the Grafenstaden works and had already been delivered in 1902. But it had only been in use two months and consequently had only run 2,046 kilometres (1,271 miles). Nevertheless it was not in good condition; the tube joints at the fire-box end were leaky, and some of the driving rod bearings and one carrying axle bearing ran hot. It was therefore necessary to repair the locomotive before the trials. As it ran unsteadily at high speeds, it was overhauled after the trial runs and carefully examined; but apart from a slight amount of play in the bearings of the driving axle, no special reason for the unsteady running could be discovered. The third locomotive, the Elberfeld one, was an express locomotive using superheated steam; it was a non compound with two cylinders, of the 4-4-0 type. It was built by Borsig and delivered in 1903; it had only been two months in use but had already run 11,560 kilometres (7,183 miles). It also was not in good condition.

The chief dimensions of the three locomotives are as follows :

	Four-cylinder compound express, 4-4-2 type, Hanover.	Four-cylinder compound express, 4-4-2 type, Grafenstaden.	Two-cylinder non compound using superheated steam. 4-4-0 type, Borsig.
	1	2	3
Working pressure, in kilograms per square centimetre (in lb. per square inch) . . . . .	14 (199·1)	14 (199·1)	12 (170·7)
Diameter of cylinders, in millimetres . . . . .	2 of 360 and 2 of 560 2 of 1 ft. 2 <sup>3</sup> / <sub>16</sub> in. and 2 of 1 ft. 10 in.	2 of 340 and 2 of 560 2 of 1 ft. 1 <sup>1</sup> / <sub>8</sub> in. and 2 of 1 ft. 10 in.	2 of 530 (2 of 1 ft. 8 <sup>7</sup> / <sub>8</sub> in.)
Length of stroke, in millimetres . . . . .	600 (1 ft. 11 <sup>1</sup> / <sub>8</sub> in.)	610 (2 ft. 1 <sup>1</sup> / <sub>16</sub> in.)	600 (1 ft. 11 <sup>1</sup> / <sub>8</sub> in.)
Diameter of driving wheels, in millimetres . . . . .	1,980 (6 ft. 6 in.)	1,980 (6 ft. 6 in.)	1,980 (6 ft. 6 in.)
Heating surface (superheater included), in square metres (in square feet) . . . . .	162·90 (1,753·50)	155·30 (1,671·70)	101·7 + 30·75 (1,094·73 + 331)
Grate area, in square metres (in square feet) . . . . .	2·70 (29·06)	2·72 (29·28)	2·97 (31·97)
Weight in running order, in tons (in English tons) . . . . .	59·82 (58·88)	63 (63·97)	54·50 (53·64)
Adhesive weight, in tons (in English tons) . . . . .	30·40 (29·92)	32 (31·49)	30·80 (30·31)
Weight of tender, loaded, in tons (in English tons) . . . . .	43·36 (42·68)	47·80 (47·05)	42 (41·34)
Wheelbase of locomotive, in metres . . . . .	9 (29 ft. 6 in.)	8·200 (26 ft. 11 in.)	7·660 (25 ft. 1 <sup>1</sup> / <sub>8</sub> in.)
Total wheelbase of locomotive and tender, in metres . . . . .	15·400 (50 ft. 6 in.)	15·400 (50 ft. 6 in.)	15·100 (49 ft. 7 in.)
Coal carried, in tons . . . . .	5	5	4
Water carried, in tons . . . . .	19	20	16

The necessary observations and readings were taken, while running, at intervals of a minute. In addition to the speeds (recorded in kilometres per hour), observations were made and records taken of the pressure in the boiler, in the high pressure valve chest and in the intermediate receiver, of the percentages of cut-off in the high pressure and low pressure cylinders, and of the vacuum in the smoke-box. Moreover, the level of the water in the boiler and the position of the regulator, were noted frequently. Finally, as the trials were more particularly intended to give information as to material consumed, the water fed into the boiler by the injector was also recorded, and the water used on the coal. Exact measurements were also taken of the coal used while lighting the fires and while running, and of the lubricating materials used. Finally, the air temperature and the feed-water temperature were also measured, as well as the force and direction of the wind.

The maximum speeds attained by these locomotives, when running alone, were : locomotive No. 1, 143 kilometres (88·9 miles) per hour; locomotive No. 2, 132 kilometres (82 miles) per hour; locomotive No. 3, 132 kilometres (82 miles) per hour. When hauling trains, the three locomotives ran at the following average speeds :

a) When hauling a train of 40 axles :

	Time required for whole run, all stops included.	Total time lost.	Net time of running.	Calculated speed.
Locomotive No. 1. .	176 minutes.	19 minutes.	157 minutes.	93 kilometres (57·8 miles) per hour.
— No. 2. .	195 —	29 —	166 —	88 — (54·7 — ) —
— No. 3. .	179 —	17 —	162 —	90 — (55·9 — ) —

b) When hauling a train of 20 axles :

	Time required for whole run, all stops included.	Total time lost.	Net time of running.	Calculated speed.
Locomotive No. 1. .	171 minutes.	28 minutes.	143 minutes.	103 kilometres (64 miles) per hour.
— No. 2. .	171 —	18 —	153 —	95 — (59 — ) —
— No. 3. .	171 —	26 —	145 —	101 — (62·8 — ) —

The actual acceleration, after running five minutes, was :

	Locomotive		
	No. 1.	No. 2.	No. 3.
Train of 40 axles . . .	11 kilom. (6·8 miles) per minute.	12 kilom. (7·5 miles) per minute.	12 kilom. (7·5 miles) per minute.
— of 20 — . . .	16 kilom. (9·9 miles) per minute.	16 kilom. (9·9 miles) per minute.	14 kilom. (8·7 miles) per minute.

Or, per 100 tons of gross load hauled ;

	Locomotive		
	No. 1.	No. 2.	No. 3.
Train of 40 axles . . .	46 kilom. (28·6 miles) per minute.	51 kilom. (31·7 miles) per minute.	49 kilom. (30·4 miles) per minute.
— of 20 — . . .	40 kilom. (24·9 miles) per minute.	42 kilom. (26·1 miles) per minute.	35 kilom. (21·7 miles) per minute.

The times of running before attaining : a) a speed of 100 kilometres (62·1 miles) per hour

with the 40 axle train; *b*) a speed of 120 kilometres (74·6 miles) per hour with the 20 axle train, amounted on the outward journey (from Hanover, allowing for a service slack) to :

	Locomotive		
	No. 1.	No. 2.	No. 3.
<i>a</i> ) . . . . .	26 minutes.	29 minutes.	36 minutes.
<i>b</i> ) . . . . .	23 —	22 —	25 —

and after starting from Stendal, also allowing for a service slack :

	Locomotive		
	No. 1.	No. 2.	No. 3.
<i>a</i> ) . . . . .	13 minutes.	21 minutes.	18 minutes.
<i>b</i> ) . . . . .	16 —	21 —	18 —

Grouping together the different speeds attained, we obtain the following table :

<i>Train of 40 axles :</i>	Locomotive		
	No. 1.	No. 2.	No. 3.
Mean speed . . . . .	93 kilom. (57·8 miles) per hour.	88 kilom. (54·7 miles) per hour.	90 kilom. (55·9 miles) per hour.
Speed when constant . . . . .	108 kilom. (67·1 miles) per hour.	106 kilom. (65·9 miles) per hour.	108 kilom. (67·1 miles) per hour.
Maximum speed. . . . .	125 kilom. (77·7 miles) per hour.	112 kilom. (69·6 miles) per hour.	112 kilom. (69·6 miles) per hour.

<i>Train of 20 axles :</i>			
Mean speed . . . . .	103 kilom. (64·0 miles) per hour.	93 kilom. (57·8 miles) per hour.	104 kilom. (62·8 miles) per hour.
Speed when constant . . . . .	124 kilom. (77·1 miles) per hour.	118 kilom. (73·3 miles) per hour.	118 kilom. (73·3 miles) per hour.
Maximum speed . . . . .	133 kilom. (82·6 miles) per hour.	129 kilom. (80·2 miles) per hour.	124 kilom. (77·1 miles) per hour.

The principal data referring to the performances of the locomotives are given in the following table :

	Forty-axle train.			Twenty-axle train.		
	1	2	3	1	2	3
Weight of train, in tons (in English tons) . . . . .	320 (315)			158 (155·5)		
Mean axle-load, in tons (in English tons) . . . . .	8 (7·9)			7·9 (7·8)		
Axle-kilometres (axle-miles), section 243·5 kilometres (151·3 miles in length) . . . . .	9,740 (6,052)			4,870 (3,026)		
Ton-kilometres (English ton-miles) hauled . . . . .	77,920 (47,653)			38,473 (23,529)		
Mean weight of locomotive in running order, in tons (in English tons) . . . . .	94 (92·5)	103 (101·4)	89 (87·6)	94 (92·5)	103 (101·4)	89 (87·6)
Total ton-kilometres (English ton-miles) . . . . .	100,809 (61,652)	130,000 (79,504)	90,592 (60,907)	61,362 (37,527)	63,554 (38,868)	60,145 (36,733)
Horse-power used up by locomotive itself when running at constant speed (British horse-power) . . . . .	572 (564)	522 (515)	612 (604)	795 (784)	671 (662)	759 (749)
Mean indicated horse-power (British horse-power) . . . . .	1,121 (1,106)	1,001 (987)	1,063 (1,068)	982 (969)	810 (799)	903 (891)
Indicated horse-power when running at constant speed (British horse-power) . . . . .	1,544 (1,523)	1,451 (1,431)	1,585 (1,563)	1,499 (1,479)	1,285 (1,267)	1,373 (1,354)

When running alone, locomotive No. 1 was still perfectly steady at the highest speeds, so that the speed might have been increased still further. But the speed of the Grafenstaden locomotive was limited by the fact that too much sideway oscillation set in. This is, however, attributed to the condition of the locomotive rather than to its design. The locomotive using superheated steam only showed slight sideway oscillation; at the cab end, there was some up and down motion, possibly because the bearing springs were too stiff. But when running at speeds of 115 kilometres (71.5 miles) per hour, this locomotive showed a remarkable endway oscillation, which became more marked later on, when the play increased, and which was then already very appreciable at 100 kilometres (62.1 miles) per hour. Similar observations had already been made during the trial runs of a three-cylinder locomotive of the 4-8-0 type. An explanation of this phenomenon has not yet been given. Mr. Leitzmann thinks it depends on the conditions of pressure under which the steam works in the cylinders. It would thus be necessary to alter the compression of the steam when the speed is materially increased; for according to Leitzmann, this forms the only counterbalance to the action of the non-balanced masses, which increases as the square of the speed. If there is not sufficient compression, the moment at which the action is reversed approaches dangerously near to the dead point, and then under certain conditions shocks may be produced of sufficient violence to break up the whole engine, as has already happened in the case of marine engines. But as probably the compression increases also more quickly than the velocity, it seems that there is a certain critical velocity at which the action of the masses is a maximum. This theory is confirmed by the results of some experiments; and it tends to show that endway oscillation can be overcome by increasing the critical velocity by a suitable system of construction and by making it exceed practical limits to such an extent as to become negligible.

There are also other points in which the locomotive requires improvement. Firstly, its power must generally speaking be sufficiently increased to enable it to haul a load of 30 axles, for it is hardly probable that an economic service could be run with smaller loads. In the trial runs in fact the useful horse-power only amounted to 44 per cent of the indicated horse-power, when the 20 axle train was hauled. Moreover, all the different parts require to be designed to suit the higher speed; thus it is necessary to increase the diameter of the driving wheels so that the rate of revolution of the wheels and the speed of the piston may be reduced to the values now admitted. In the trial runs, the driving wheels of the three locomotives, at 120 kilometres (74.6 miles) per hour, revolved 5.36 times per second, and the mean piston speed was 6.6 metres (21 ft. 8 in.) per second. The strength of the driving mechanism also is of course of much importance.

As already observed, it is also necessary to increase the compression of the steam in the cylinders, by giving the slide valves suitable dimensions, so that the greater action of the masses may be counteracted. At very high speeds, exceeding 110 kilometres (68.4 miles) per hour, it seems that from the point of view of reducing these actions, the four-cylinder type of locomotive is the only type to be considered, and that with each pair of cylinders directly opposite each other, so that the wheels may require no counterweights.

As regards the fuel consumption, the trial runs showed that in this case also, although the distances run were fairly long, the quantity of coal required for lighting up was 25 per cent of the quantity consumed while running; then also that the consumption of fuel per train-kilometre was very high and exceeded 12 kilograms (42.5 lb. per train-mile). Per unit of time and distance, the locomotive using superheated steam consumed least coal. It was also very economical as regards amount of steam used, and so these trial runs once more give evidence in favour of the superiority

of superheated steam. It was only from the point of view of wear and tear that the boiler of the locomotive using superheated steam (of small dimensions it is true; see table of chief dimensions) came last, whereas the Grafenstaden locomotive came first. It follows, as before, that special attention should be paid to locomotives using superheated steam.

---

## THE PASSENGER SERVICE ON THE CEYLON RAILWAYS,

By Messrs. BLUM and E. GIESE,

GOVERNMENT ENGINEERS.

Figs. 1 to 6, pp. 1680 to 1684.

(*Zeitung des Vereins.*)

Geographically the luxuriant tropical island of Ceylan forms part of India, but judged by its inhabitants, its religion and its culture, by its mountainous character, by its exceedingly great fertility, it differs essentially from the Indian Continent and is much more nearly akin to Burmah and Java, both in appearance and in its conditions of life. From a political standpoint too, Ceylon is a colony independent of the Indian empire. Moreover, its trade and business relations with the Indian Continent are not very close, and at present are only assured by a daily service of steamers between Colombo and Tuticorin. True, at this moment, there is a scheme on foot for starting a direct connection by rail between India and Ceylon by means of a line across Palk strait. This undertaking is far from being as immense as it might seem at first sight, for the strait is very shallow and is studded with a continuous series of islets and sandbanks forming what is known as Adams Bridge. It is proposed at the same time as this railway is built — it would be mainly laid on an embankment — to make a canal which would render Palk strait navigable for ships of a certain draught. At present they cannot get through, and the possibility would shorten the route considerably from Aden to Madras, Rangoon and Calcutta.

The most important railways in Ceylon (*vide fig. 1*) are the two lines from Colombo, one going south to connect with Galle and Matura, the other piercing the centre of the country towards Kandy, Matale and Bandarawela. It is proposed to make another line northwards from Colombo, and this would eventually be extended to India; a short section of this line, in the northern part of the island, is already open. The lines so far mentioned, are broad gauge (5 ft. 6 in.), the selection of which can scarcely be regarded as fortunate for Ceylon, because in this comparatively small but very hilly country, it is not even our normal gauge but rather metre gauge (3 ft. 3  $\frac{3}{8}$  in.) that ought to be used. So for two secondary lines more recently built, in order to reduce the cost of construction, the broad gauge has been given up and one of 2 ft. 6 in. has been selected. This little country has, therefore, several gauges.

The importance of the Ceylon railways lies in their qualification of serving as feeders for conveying to Colombo, the main centre of foreign trade, the wealth of the country, especially tropical fruits, graphite and tea. The line going eastwards is, moreover, of special importance, because it makes it easy for Europeans to get quickly to the healthy hill resorts. In building and working the lines, no notice had to be taken of the habits of the natives, because, having been subdued long since, they soon became familiarized with European customs, in so far as was neces-

sary for railway business. As the Ceylon lines were built for the Government by English engineers, one naturally finds mostly English methods of construction, but these have been very cleverly adapted to the needs of a tropical climate.

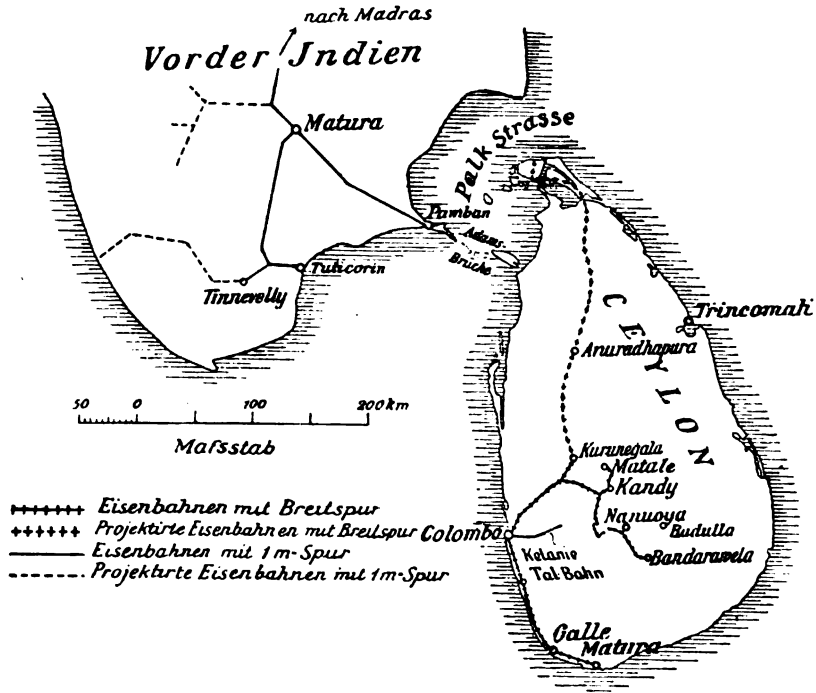


Fig. 1. — Map of Ceylon and Southern India.

*Explanation of German terms :* Adams Brücke = Adams bridge. — Eisenbahnen mit Breitspur = Broad gauge lines. — Eisenbahnen mit 1 m. Spur = Metre-gauge (3 ft. 3 3/8 in.) lines. — Massstab = Scale. — Nach Madras = Towards Madras. — Palk-Strasse = Palk Strait. — Projektirte Eisenbahnen mit Breitspur = Projected broad gauge lines. — Projektirte Eisenbahnen mit 1 m. Spur = Projected metre-gauge (3 ft. 3 3/8 in.) lines. — Vorder-Indien = British India.

Train-speed is not high; this is due to the hilly character of the country and does not seem to trouble passengers very much as the distances are by no means great. The table below shows the average inclusive speed of the best trains and the number of pairs of through trains on the three most important lines.

RAILWAY.	Length, in kilometres (in miles).	Time of journey, in hours.	Average speed, in kilometres (in miles) per hour.	Number of pairs of through trains.
Colombo-Galle . . .	119 (73·9)	3·35	31·7 (19·7)	4
Colombo-Kandy . . .	121 (75·2)	3·45	32·3 (20·1)	4
Peradeniya-Nanuoya .	92 (57·2)	4·25	20·7 (12·9)	5

The speed of stopping trains seldom exceeds 18 kilometres (11·2 miles) an hour, and on the narrow-gauge lines falls as low as 10 kilometres (6·2 miles). The average inclusive speeds which we met with on the different lines and the general average speed are shown in the table below :

DATE.	JOURNEY		Kind of train.	Gauge, in metre (in feet and inches).	Departure	Arrival.	Distance, in kilometres (in miles).	Time on journey, in hours.	Average inclusive speed, in kilometres (in miles) per hour.
	from	to							
March 5, 1904. .	Colombo.	Mount Lavinia.	Suburban train.	1·67 (5' 6")	4·35	5·10	11 (6·8)	0·35	18·9 (11·7)
— 5, — . .	Mount Lavinia.	Colombo.		1·67 (5' 6")	6·15	7·02	11 (6·8)	0·48	13·8 (8·6)
— 6, — . .	Colombo.	Waga.	Mixed train.	0·76 (2' 6")	2·35	4·16	16 (9·9)	1·41	10·0 (6·2)
— 6, — . .	Waga.	Colombo.		0·76 (2' 6")	4·41	6·24	16 (9·9)	1·43	10·0 (6·2)
— 8, — . .	Colombo.	Kandy.	Through train.	1·67 (5' 6")	2·15	6·00	121 (75·2)	3·45	32·3 (20·1)
— 9, — . .	Kandy.	Matale.	Mixed train.	1·67 (5' 6")	2·45	3·54	26 (16·2)	1·09	22·6 (14·0)
— 9, — . .	Matale.	Kandy.		1·67 (5' 6")	4·10	5·17	26 (16·2)	1·07	23·2 (14·4)
— 10, — . .	Kandy.	Nanuoya.	Train stopping everywhere.	1·67 (5' 6")	10·30	3·20	99 (61·5)	4·50	20·5 (12·7)
— 10, — . .	Nanuoya.	Nuwara-Eliya.		0·76 (2' 6")	3·50	4·35	10·5 (6·5)	0·45	14 (8·7)
— 11, — . .	Nuwara-Eliya.	Nanuoya.	Through train.	0·76 (2' 6")	8·45	9·30	10·5 (6·5)	0·45	14 (8·7)
— 11, — . .	Nanuoya.	Colombo.		1·67 (5' 6")	9·40	5·45	207 (128·6)	8·05	25·5 (15·8)
Totals. . .	...	...	...	...	...	...	554 (344·1)	25·13	22 (13·6)

The low speed is in some measure compensated for by the large number of connections. The number of pairs of through trains which, according to the last column of the first table, is from four to five, must be regarded as comparatively high, especially as many trains are interpolated on some sections. Of the two lines running into Colombo, one runs seven and the other thirteen pairs of trains, without counting a large number of suburban trains.

In accordance with English custom, the Sunday time-table is different and shows much fewer trains. At Colombo, there are no through cars between the Kandy and Galle lines; but the circumstances do not require this. On the other hand, through trains are run on the Colombo-Kandy, Colombo-Bandarawela and Kandy-Bandarawela lines. The point at which these trains meet, is Peradeniya, and consequently the time-table is arranged so that three through trains meet there each time; they are split up into two portions and the corresponding through cars are marshalled into three new trains. Despite the comparatively short sections, one night train runs between Colombo, Kandy and Bandarawela, because in the hot season the journey by day is very trying, and often even rather dangerous, for Europeans <sup>(1)</sup>.

In Ceylon, as in most tropical countries, there are three classes of carriages, the first being utilised almost exclusively by Europeans, the second by Europeans, half-breeds and wealthy natives and the third by natives only. The seats of the first and second class cars are upholstered

<sup>(1)</sup> As regards night trains, Ceylon differs advantageously from Java, where trains only run in the day time.

or covered with split cane; in the third class cars the seats are wooden. Most of the cars are eight wheeled, with two bogies. On the broad-gauge lines they have two buffers, whereas on the narrow-gauge lines a central buffer and drawgear has been adopted. In the third class, the floor arrangement is like ours with transverse compartments. The sides often do not reach beyond half way up the body. Transverse compartments are also often met with in the 1<sup>st</sup> and 2<sup>nd</sup> class cars, but apparently a preference is shown for rather larger compartments and as these are arranged in many different ways there is considerable variety in subdividing the floor space. Figure 2 represents a 1<sup>st</sup> class car, comprising three large compartments for ladies, smokers and

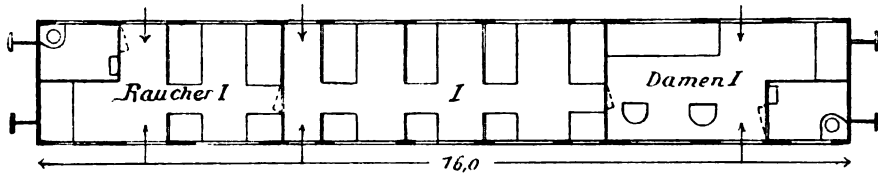


Fig. 2.

Explanation of German terms : Damen = Ladies. — Raucher = Smoking.

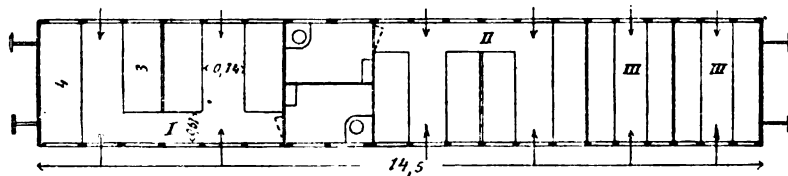


Fig. 3.

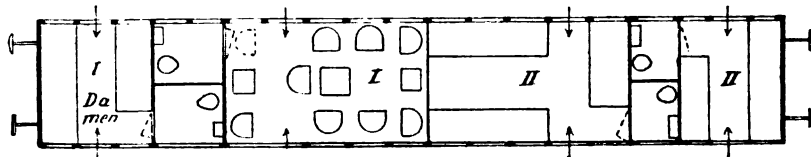


Fig. 4.

non-smokers. The backs of the seats for two persons in the centre compartment can be reversed, as on the American railways, so that a passenger can travel facing or with his back to the engine as he chooses. As regards the seats for one person, a berth can be made between two seats by folding down one of the backs; moreover, the back can be adjusted at different angles. Figure 3 shows a car for 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> class where two 1<sup>st</sup> and two 2<sup>nd</sup> class compartments are arranged so that the lavatories, situated in the middle, are accessible from either side. For longer journeys, the 1<sup>st</sup> and 2<sup>nd</sup> class car, shown in figure 4, has been found very convenient. For each class, it contains a small transverse compartment into which passengers, especially ladies, who want to be alone, can retire, and two larger compartments of which the 1<sup>st</sup> class one has moveable armchairs, rendering it possible to look out readily; the 2<sup>nd</sup> class large compartment is fitted, as the carriages on the Indian railways, with transverse and longitudinal seats.

As regards the fittings of the cars, we ought to mention the double roof and the double sides,

used as on the Indian railways, to protect the interior from the direct action of the sun's rays. The special side walls of the 1<sup>st</sup> and 2<sup>nd</sup> class cars go down so low, that the parts situated at the doors have to be made moveable. But as this is expensive, these protecting sides stop short at a height sufficient to allow of the doors being still capable of being opened below them (*vide* fig. 5). Consequently, the protection against the sun's rays is less efficient than with sides that reach lower down, but it is not necessary for it to be as good, because the natives travelling third class feel the heat much less. In order to have as free a passage as possible for the air, the sides are perforated with openings and these can be closed, in the 1<sup>st</sup> and 2<sup>nd</sup> class, by windows or wooden blinds. In the 3<sup>rd</sup> class, these openings are often incapable of being closed in any way. The cars are lighted by gas. There are plenty of nets for hand luggage, and

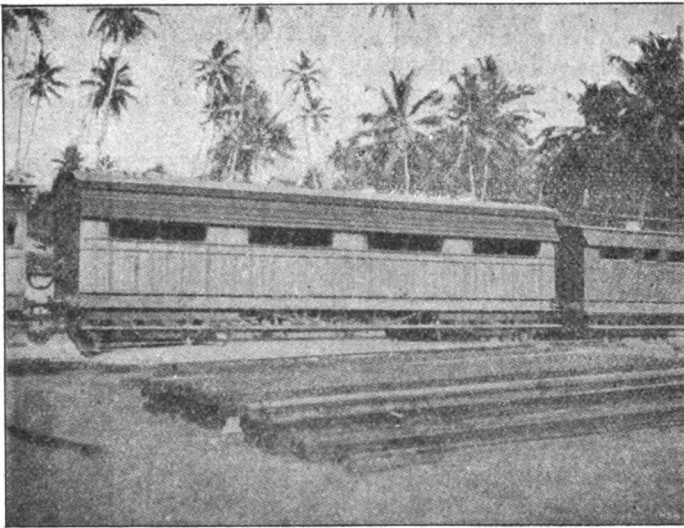


Fig. 5. — 3<sup>rd</sup> class car.

moreover, the free spaces under the seats can be utilised for this purpose as heating is unknown.

Except for a few cars used on the suburban service round Colombo, all 1<sup>st</sup> and 2<sup>nd</sup> class cars are supplied with water-closets; the latter are often devised to serve more than one compartment, and they are remarkable for their cleanliness and suitable lavatory accommodation.

The night express on the Colombo, Bandarawela and Kandy line has sleeping cars with eight beds arranged as upper and lower berths along the sides. The beds possess, therefore, the advantage of being situated longitudinally along the car. On the day expresses over the mountain line, restaurant cars are run, but these can only be used by 1<sup>st</sup> and 2<sup>nd</sup> class passengers, and they belong to a private company. These cars are built (fig. 6) with a kitchen and office at one end, and a pantry and scullery at the other. Between these two is the restaurant with three tables and seating capacity for eighteen people. The two small serving tables which take up a lot of room are little utilized. The restaurant cars are used mainly for lunch or "tiffin" which costs 2 rupees (2s. 8d.). As the trains have no corridors, there is the inconvenience of having to separate oneself from one's car and baggage altogether during the meal, if one uses the restaurant.

The fares on the Ceylon railways are about 8·25, 5·50 and 2·75 francs per 100 kilometres (10s. 7  $\frac{1}{2}$  d., 7s. 1d. and 3s. 6  $\frac{1}{2}$  d. per 100 miles) for the three classes respectively; as no reduction is made for return tickets the fares are much the same as in Germany, except that 1<sup>st</sup> class must be compared with 2<sup>nd</sup> on the German railways, 2<sup>nd</sup> with 3<sup>rd</sup>, and 3<sup>rd</sup> with 4<sup>th</sup>.

The station buildings for passengers do not offer much comfort. There is usually no kind of shelter for 3<sup>rd</sup> class passengers and this is explained by the fact that the natives who live in simple huts do not require any such luxury. In the middle of the building, there is, as a rule, for 1<sup>st</sup> and 2<sup>nd</sup> class passengers a large waiting room open towards the platform and the street and furnished with seats; on one side are the offices with windows for issuing tickets and dealing with luggage, on the other is a special waiting room labelled "ladies only", but available for European men too. Adjoining this waiting room, there is a lavatory, with a water-closet, for Europeans. For natives (3<sup>rd</sup> class passengers) there is often provided along the outside of the offices, a direct entrance on to the platform with a gate for inspecting tickets, so that they need not even pass through the station buildings. The gate is usually kept closed until after the train gets in and when this is so, no natives are permitted to go on the platform, unless they are provided with

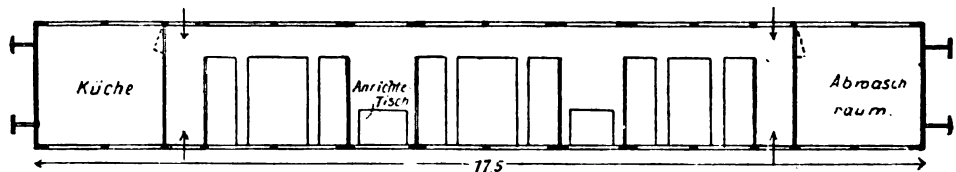


Fig. 6. — Restaurant car.

*Explanation of German terms:* Abwaschraum = Office. — Anrichte-Tisch = Serving table. — Küche = Kitchen.

tickets; but Europeans are free to pass on to the platforms. At small stations, an awning hung all round the station buildings keeps off the sun and rain. At large stations, the platforms are protected by iron coverings. Most stations have a single platform running along the station buildings; when the traffic is heavy enough to warrant several platforms, as for instance at Colombo and its suburbs, the platforms are connected together and with the station buildings by overhead bridges. There are no refreshment rooms at the stations; but they really are not needed, seeing that journeys are usually short and that the through trains have restaurant-cars attached; moreover, the way in which Europeans live at home and in hotels, would hardly lend itself to the use of refreshment rooms. On the other hand, at every station, people walk up and down selling refreshments, especially all kinds of splendid tropical fruit. There are also, vieing in zeal with these salesmen, native women belonging to the salvation army who, here too, ardently issue their appeal to arms.

To sum up, we may assert that one can travel with more pleasure on the Ceylon railways than upon those of the other tropical countries we have visited (Siam, Java, British-India and Indo-China). We must add that this difference is mainly due, not to any special technical superiority, but to the sum-total of the country's circumstances, to its hilly and sea climate, to its older culture and above all to the ever varying beauty of this gorgeous tropical island. The journey from Colombo to Kandy and above all the trip to Mount Lavinia, are some of the most beautiful within the tropics.

# PROCEEDINGS

OF THE  
SEVENTH SESSION

WASHINGTON : MAY, 1905

---

3<sup>rd</sup> SECTION. — WORKING.

---

[ 686 .23 ]

QUESTION XII.

---

## SUBURBAN TRAFFIC

---

*Arrangements for suburban passenger traffic.*

*Reporters :*

*America.* — Mr. A. W. SULLIVAN, assistant second vice-president, Illinois Central Railroad.

*Other countries.* — Mr. H. G. DRURY, superintendent of the line, Great Eastern Railway.

---

## QUESTION XII.

---

## CONTENTS

---

	Pages.
Sectional discussion . . . . .	1687
Sectional report . . . . .	1707
Discussion at the general meeting. . . . .	1707
Conclusions . . . . .	1709

### PRELIMINARY DOCUMENTS.

Report No. 1 (America), by A. W. SULLIVAN. (See the *Bulletin* of October, 1904, p. 1055.)

Report No. 2 (other countries), by H. G. DRURY. (See the *Bulletin* of December, 1904, p. 1545.)

Vide also the separate issues (in red cover) Nos. 9 and 15.

---

## SECTIONAL DISCUSSION

---

Meeting held on May 6, 1905 (morning).

---

MR. H. TYLSTON HODGSON, PRESIDENT, IN THE CHAIR.

**The President.** — I will now ask Mr. Hyde, who is the assistant general manager of the Great Eastern Railway Company of England, to read the paper written by Mr. Drury, late superintendent of the Great Eastern Railway Company.

**Mr. W. H. Hyde,** Great Eastern Railway, Great Britain. — Mr. President and gentlemen, I might first of all explain that Mr. Drury, who wrote the paper on "suburban traffic," has retired from the service of the company since the preparation of his report, and I have been asked to express a few matters with regard to that paper, not going fully into detail, but just touching upon the main points.

The question of suburban traffic which we have to consider, is distinguished from that which is wholly or partly urban, by the fact that the bulk of the traffic is confined to a period of a few hours, in one direction in the morning and in the reverse direction in the evening.

If you will turn to pages 120 and 121 of Mr. Drury's report (<sup>1</sup>), you will see that almost without exception, the busy period is of short duration.

It therefore becomes necessary to provide a maximum of accommodation which is required only during certain rush hours, and which during those hours, must afford the most complete and expeditious service possible.

So far as details are concerned, the principal points to be considered are as follows :

- 1° The number of passengers to be conveyed;
- 2° The types of engines used;
- 3° The types of carriages used;
- 4° The speed of trains;
- 5° The duration of stoppages;
- 6° The system of signalling;
- 7° The track accommodation.

---

(<sup>1</sup>) Vide *Bulletin of the Railway Congress*, No. 12, December, 1904, pp. 1592 and 1593.

The first point, *viz.*, that of the numbers to be conveyed, to some extent governs the rest, due consideration being given to the question of future expansion of traffic.

Looking at the report, we find that as shewn on pages 121 and 122, the greatest density of traffic occurs in London, and that in Paris also the numbers are large. In the other instances, the figures vary from 60,000 to 2,000 each way.

With quantities such as the last mentioned, we may presume that there is no special difficulty in handling the traffic.

Consequently, our attention will be more particularly directed to the centres where the numbers are so vast as to demand facilities which are unnecessary elsewhere.

As a concrete case, there is perhaps no better illustration than in that of the Great Eastern Railway with which I am connected.

Allowing for the journeys of season ticket holders, its passengers number 140 million per annum, and as a large proportion of this number relates to suburban traffic, it will readily be seen that the transportation difficulty is a real one.

So far as the engines are concerned, those employed in the suburban service are all of the type known as the tank. The suburban lines branch out in all directions like the fingers of a hand and the conditions of traffic vary according to the locality.

On certain of the branches where frequent stops occur, six wheeled coupled engines are employed on account of their capability of starting away quickly with heavy loads. The wheels are 4 feet in diameter and the boiler carries a pressure of 180 lb.

On other branches where longer runs exist, four coupled engines are employed. These have a trailing bogie or a leading and trailing pair of wheels apart from the coupled wheels, which vary from 4 ft. 11 in. to 5 ft. 8 in. in diameter, the boiler pressure being 160 lb.

The trains are made up to 15 or 16 coaches and will shortly be lengthened to 17.

Except on a few unimportant services, the carriages are all of the widened type, seating 6 a side in the 2<sup>nd</sup> and 3<sup>rd</sup> classes and 5 a side in the 1<sup>st</sup> class.

A typical train of 15 coaches provides accommodation for 768 passengers and weighs empty just under 160 tons, this working out to an average of 4 cwt. per passenger.

The dead weight is minimised so as to facilitate rapid acceleration of speed.

In order to call attention to the importance of the latter question, I may mention that many of the stops are only two or three minutes apart.

The stoppages at stations are reduced to the lowest possible limits consistent with the safe and effectual working of traffic and average only twenty-eight seconds.

To assist in bringing about this result, the trains are made up in certain set forms, so that passengers accustomed to travel may lose no time in entering their carriages.

The system of signalling adopted is that of the Sykes electrical lock and block and as it is already familiar to you, requires no description.

So far as the track accommodation is concerned, it consists at Liverpool Street of eighteen platform-lines, two thirds of which are available for suburban traffic. Six lines, that is three up and three down, extend from Liverpool Street to a point a little over a mile to the east, where they divide into four extending 3 miles north and another four reaching to 12 miles east; otherwise the tracks are all double, with the exception of one short unimportant branch. By means of the four tracks the fast and slow traffic are separated, trains being diverted from one line to another according to requirements.

Coming to the question of the busy hours, it is mentioned in the report that the up-traffic in the morning is divided into sections according to the fares charged, the workmen's 2d. trains arriving up to 7 o'clock, the 3d. trains to 7.30, and the half fare up to 8 o'clock, after which ordinary fares prevail.

The greatest congestion occurs just before 8 o'clock, when from one place alone and within nine minutes, 4,200 passengers arrive in five trains. When it is remembered that, concurrently with this, other trains are arriving from other points, the density of traffic will be readily appreciated.

The evening traffic is more evenly distributed and is spread over a longer period.

I may mention one thing, which is not touched upon in the report, and that is the arrangement for discontinuing certain of the trains in foggy weather.

It has been found that in foggy weather, the trains become overcrowded owing to delays, and that the punctual working of the traffic is rendered almost impossible owing to the great number of trains on the road, each delaying the other.

In order to avoid this as far as possible, notices are exhibited at all the stations to the effect that certain of the trains are liable to be cancelled in foggy weather; consequently, the passengers are aware of what is likely to occur and make their arrangements accordingly.

Necessarily some overcrowding takes place, but that is preferable to overcrowding plus delay.

In conclusion, I may mention that the question of electrical traction for suburban traffic is receiving our very close attention, but at the present time no system exists which could economically be substituted for steam power.

**The President.** — This is a question that becomes to all of us more and more important every day. It is not, I think, a question, like the one of yesterday, that is likely to lead to controversy as to various systems of meeting the difficulties involved, but it is one on which we want to learn all that has been done to meet the difficulties in the past, and to get fresh means toward meeting the difficulties of the future. This matter has been in England a problem for forty years, and is an increasing one every day. On the continent it has also been an old question, increasing more and more in importance. In America, where the centers of large population have not been so numerous, at any rate till lately, it is a question that has only arisen within comparatively modern times, but it is a question upon

which we shall all try to pick out from one another's experience all the information that may lead to lessening the trouble which this suburban traffic brings.

I think it will now be convenient to ask Mr. Sullivan to read his paper, before we have any discussion upon the subject.

**Mr. A. W. Sullivan, reporter for America.** — Mr. President and gentlemen, in explanation of the form of this report, I would say that when the subject was assigned to me by the permanent commission, I was asked to confer with Mr. Drury of the Great Eastern line of England, reporter for the other countries, and so arrange a series of questions to be asked that the character of the information obtained in America would fit in with that obtained for Europe, so that when the statistics were put together some satisfactory comparison could be made. As a result of that collaboration, the questions that were sent out by each reporter were exactly alike, and the work of compiling the report has been largely the preparation of a synopsis of the data obtained in response to the inquiries that were made. In following out that form of investigation, this condition has arisen, that there has been accumulated a great fund of information as to practice in the handling of suburban traffic upon different railways of the world, and that information will doubtless be of use to any student of the subject who may care to look into it; but, for the purposes of this discussion it is hardly necessary to go into that portion of the report which is of a statistical character, except perhaps to refer to it in passing, as the authority or basis of the information for the conclusions which are reached at the end of the report.

As a rule, the conditions surrounding suburban traffic are very much alike except that in many places we find in this country a reversal of the conditions that I am informed obtain abroad. That is, that the working population in most places abroad, live on the outside and come into the cities to work. My information is that that is the practice in England; whereas in America — and I refer more particularly to the larger cities — the working population lives within the cities and goes outward to work. As a result of these conditions, there are some differences in the traffic which will probably be found in the fact that in this country there has been little or no demand for what are called working-mens' trains which are found to be such a problem in England.

Section 2 relates to "tolls, fares and tickets". There is to be found almost every variety of method and idea in the various ways in which those arrangements are made upon American railways, but the practice is universal in this country, so far as suburban service strictly speaking is concerned, to make the collection of tickets or fares upon the trains while in motion. There are some disadvantages in that, and some advantages. It is a necessary condition where there is a different rate of fare; that is, where a distance tariff prevails. The system of collection at stations as practised upon the metropolitan lines can only be carried out where there is a uniform rate of fare. For the purpose of protecting the suburban revenues it has

been found necessary upon most railways to maintain different rates of fare according to distance, which renders necessary the practice of making the collections on the trains while in motion.

I may say that generally the attitude of American railways is unfriendly to suburban traffic. A few railways have quite a dense traffic, and upon those lines which have found the traffic to be productive of satisfactory revenue, the suburban train service has been separated from the other service, and in the case of the Illinois Central in Chicago, has been brought to a state of development that it is not only earning its due proportion of the revenues of the line but is being operated without any interference with the through passenger service and without any confusion, or without requiring any undue attention on the part of the officials of the road.

The 3<sup>rd</sup> section of my report gives some data about the peculiarities of suburban lines and their tracks.

The 4<sup>th</sup> section deals with signals, but I did not dilate upon this subject, because the signal question will be dealt with separately in another report.

As regards the staff, there is as a rule no specialisation; the officials and employees attending to the suburban traffic fulfil, at the same time, other duties appertaining to the general passenger traffic.

No American railway has so far adopted electric traction for suburban traffic; however, the New York Central is at this moment making arrangements for operating its trains in New York by electricity.

As regards rolling stock, I believe this to be the crucial point. What is of special importance is the type of cars employed. Full information on this subject is given in my report.

The 8<sup>th</sup> section deals with the running of the trains, the speed, etc.

When we come to regularity in the running of the trains and their keeping to schedule time, suburban service is found to be in this respect quite satisfactory. This regularity is dependent upon the following :

1° Time-tables judiciously arranged; 2° good service of locomotives; 3° excellent organization, *i. e.*, not only must employees become familiar with the service regulations but also sending off trains and shunting must be carried out with rapidity; 4° strict discipline; 5° trains must leave termini punctually; 6° stoppages must be reduced and the getting in and out of passengers at intermediate stations must be accelerated. In this way, expenditure of motor power requisite to make up time is restricted and the zeal with which the service is conducted reacts upon passengers who are thus soon to bestir themselves likewise; 7° filling empty seats while the train is in motion; 8° prompt and efficient methods of collecting tickets and fares for seats.

Section 9 deals with special measures as regards workmen.

In the United States and in Canada, there are no general laws requiring the running of special trains for the conveyance of workmen.

Finally, the last part of my report gives statistical data and details about the traffic, the number of passengers, station, shunting, etc.

As regards financial returns, *i. e.*, the net proceeds from traffic, the American companies do not favour suburban traffic which they regard as paying badly. Still some companies have instituted a suburban service distinct from the general service. I have not been able to determine the cost of working a suburban train exactly, because few companies keep accounts of the expenses involved in suburban traffic. The expenditure under this head is included in the general balance sheet.

Nevertheless, thirteen companies in the United States and Canada have sent in an estimate of the expenditure due to suburban service. These estimates vary from 30 cents per train-mile, to 1 dollar per train-mile on very busy lines; the average cost for all the railways which have replied to this question being 61 cents per train-mile.

As to whether the earnings of suburban traffic ought to prove remunerative, the general opinion is that the service of suburban trains ought to be regarded from the standpoint of its necessity and the public convenience, rather than as a financial affair.

I shall now read the conclusions of my report. They are as follow :

1. — Suburban passenger traffic is found to consist in the safe and expeditious movement of large numbers of passengers for short distances at low rates of fare.

2. — To be in the highest degree remunerative, the traffic must be handled rapidly, by methods that are simple and inexpensive, and with the minimum working organization necessary for the purpose.

3. — To obtain these results :

- a) The station accommodations must be convenient of ample capacity;
- b) The arrangements for passengers to go to and from the trains must be short and direct, and the station platforms level with the floors of the cars;
- c) Cars must be of large capacity, with side-doors to give the greatest freedom of movement for entrance and exit;
- d) Provision must be made for distribution of passengers throughout the train while in motion;
- e) Adequate safeguards must be provided for protection against personal injury, chiefly for the purpose of preventing passengers from entering or leaving the cars while in motion;
- f) Trains must be of the greatest capacity consistent with economical movement.

4. — The car, as the vehicle of transportation and the primary unit, is the factor to which everything else must conform.

5. — In the case of new lines to be constructed, the type of car should first be determined and the railroad then designed to fit the car.

6. — In the case of old lines, to develop the greatest transportation capacity, the car should be of such size as will utilize in the highest degree the space between tracks upon tangents; the

curves should then be compensated to provide the same clearances as upon tangents, in order to admit of the use of a car of the maximum size upon all parts of the line.

7. — The locomotive should be proportioned to handle trains of maximum size at the speed demanded by the train schedules.

8. — The track and bridges should have stability and strength requisite to safely and economically carry at speed the locomotives and trains required for maximum traffic movements.

In explanation of this reference to tracks and bridges, it should be stated that this question is taken in its broad sense; that suburban traffic is not merely the transportation of passengers alone and by itself, for it involves all of the conditions requisite to that end, and necessarily commences with the design and construction and physical character of the roadbed and the structures for carrying it.

9. — The greatest train movement and the highest degree of safety and of economy in operation, are to be attained by schedules which provide for the movement of trains at uniform speed and stopping at all stations, upon the same tracks.

I might say in reference to this conclusion, that there has been more or less discussion as to the advisability of operating a few tracks in a highly complex manner by a signal system and so on, as against building more tracks and operating them without any of those adjuncts. Illustrative of the simpler method the practice of the Illinois Central may be mentioned, when running into Chicago; they have eight main tracks, four of the main tracks are given to suburban traffic, two of which are used for local suburban traffic, where the trains make stops at all of the stations, and two being used for express suburban traffic where the trains are brought into town at a speed of 50 or 60 miles an hour. The operation of that service for upwards of twenty years, has been marvellously successful in its freedom from casualties, which is due not so much to the care and skill of the operation as to the simplification of the methods, thereby reducing the hazard.

10. — That separate tracks should be provided upon lines of heavy traffic for trains which are run at high speed and do not stop at all stations.

11. — That an essential requisite of economical operation is to conserve the expenditure of energy, and avoid the necessity of regaining time lost, by preventing the loss of time at stations.

The explanation of that conclusion is this, that it is far better to do the station work quickly and efficiently and then move the trains at a moderate rate of speed, than it is to lose time at the stations by using slow methods for handling the passengers and then seek to regain the time so lost by the greater expenditure of energy, as for instance, by the use of large locomotives worked to their limit of capacity in an effort to make up the time that has been wasted.

It is thought to be the better policy so to construct the cars and so to operate the service, that the movements at the station are quick and short, so that there is no

necessity for making up time by the expenditure of a great amount of locomotive power because no time is lost.

12. — To this end the prompt movement of passengers should be provided for, and no loss of time should occur in the departure of trains when the purpose for which a stop is made at a station has been accomplished.

The reference in that conclusion is to this thought. Observation as to the general handling of trains shows that trains do not promptly leave the station, as a rule, when their work is finished; that unless there is some special stimulus, the work is done very leisurely and comfortably, and then after the passengers have entered or left the train, there is always a perceptible pause, an interval, before the train actually starts. Now, looking at the question in a purely technical way, that loss of time is loss of revenue, is loss of efficiency to the service, and should be considered a defect. One reason why the public makes no effort to move faster when entering or leaving the trains is because as a rule the methods of the railways themselves have not been of a character to stimulate the public to expedition. It is found that if the methods of operating the railway are prompt, decisive, effective, the public will immediately respond; that the passengers will quicken their pace, particularly so when they find that as quickly as the work is done the train instantly takes its departure.

13. — That the frequency of train movement should be proportioned to the volume of traffic, to avoid congestion at stations.

14. — The system which combines the foregoing requisites in the highest degree may be deemed the most perfect.

**The President.** — Gentlemen, we have had two papers of the highest interest read to us this morning, and the authors, in the suggestions of the one paper, and in the conclusions of the other, have crystallized for us many of the thoughts that no doubt have been present to the minds, not only of themselves, but of all who have had to deal with suburban traffic. There are four or five points in Mr. Sullivan's paper which I should just like to mention. He has drawn our attention to a table which shows the weight, the length and the breadth of car accommodation requisite for each passenger. He has drawn our attention to the necessity for every accommodation for getting people in and out of trains and letting them sort themselves when they get in. To facilitate that, on the Illinois Central, which was formerly his own road, they have introduced sliding side doors. Then he emphasizes that the arrangements should be as simple as possible for prompt and effective movement, and thus you get more promptness and more effectiveness in the action and movements of your passengers. Then, one thing which has been found everywhere, I think, is that a road with mixed traffic upon it, fast and slow, is very difficult to use up to the full amount of its carrying power.

Now, I merely mention these points, not as one who has to deal with these

matters in detail, but as one who with some length of railway experience, has seen what should be attended to, and I will now ask that the discussion should be taken up by Mr. Clear, who is the assistant goods manager of the Great Central Railway of England.

**Mr. E. A. Clear**, Great Central Railway, Great Britain. — Mr. Chairman and gentlemen, I was connected for several years with a large trunk line which has a heavy suburban traffic in London, and should like to say this is a question which very considerably affects the London companies. All of us, I suppose, look to our friends the Great Eastern Company as being almost perfect in the manipulation of their large suburban traffic. I should like to ask the London gentlemen present to give an expression of opinion as to whether a type of vehicle could be adopted similar to the Illinois Central style of carriage — with side-opening doors, and central seats. I suggest it should be a smaller size, after the pattern of the London “tube” carriage, which is of lighter construction and could be more easily hauled. Passengers could obtain entrance and exit from a vehicle of this kind very quickly. As we have arrived at the period when we have to consider seconds, everything which conserves time is a matter of importance to railway companies concerned in the prompt despatch of traffic.

**Mr. Alexander Wilson**, North Eastern Railway, Great Britain. — The Chairman was good enough to say in his opening that he would like to have the experience as far as possible of all the persons here with regard to this very important subject. In listening to Mr. Sullivan’s very able address, I was much struck by the fact he stated, that there was no company in America which operated suburban traffic by electricity, and for this reason the experience of the North Eastern may be of interest. Well the North Eastern Company about twelve months ago started, in fact they were the first company in England to commence to work a surface electric railway. There were two reasons for it which led them to decide to do this. The first was that they were losing their suburban traffic owing to the competition of the tramways. The second reason was that they desired to develop to a greater extent than they had been able to do by steam traction, their suburban traffic. I ought perhaps to say that the district where our suburban trains are operated is the Newcastle district, where there is a very dense population, and that the accommodation at our terminal station at Newcastle is very limited in extent. Well, the result of our operations for the past year have been most satisfactory. We have been able to increase the traffic over the lines. We have not yet been able to get back all the traffic which the tramways have taken from us, but we have been able to make satisfactory increases in our traffic; and not only that, but we have been able to reduce the working expenses of the lines and to get such additional revenue from the traffic as will enable us to pay a satisfactory interest on the increased capital expenditure which we had to lay out in adapting the railway for electric traction. I thought it would interest the members present to know these facts; and if any one desires to

have further information as to the details, I shall be very glad to furnish them.

The next point I should like to draw attention to in connection with our electrification, is the fact that we do not make our own power. We buy our power from a supply company, so that we have been saved the necessity of embarking upon a very large expenditure in providing large power houses and all the necessary plants. We find that that has worked very satisfactorily indeed. We get all the power we need at a very low rate, and I think I may safely say that our operations have been quite successful.

I was very much struck by what Mr. Sullivan said in regard to the importance and desirability of passengers obtaining quick ingress and egress from trains at the railway stations. This is a very important feature. We are trying to arrange a stop of thirty seconds, but this is not always possible, owing to the fact that the people cannot get into and out of the coaches quickly enough. When one comes to look at the Illinois Central stock, one can see that there might be a great deal in the fact of their having side doors which will enable all the people to get out and into the coaches more rapidly than they can by getting out and in at one door, as is our practice. I hope that we may have some further discussion upon that point.

Then, as regards his observation that the car as a vehicle of transportation and the primary unit, is the factor to which everything else must conform, — it must be remembered that England is an old country, that the railway works there were not designed for the passage of vehicles such as we see here in America, and that this makes it exceedingly difficult for us to increase the size of our existing stock. It would mean an enormous capital expenditure to adapt our railways and our gauges to take in a vehicle of the size which we would like to carry over the railways. Of course it might be desirable in some instances, where the capital expenditure would not be great, but in our case in the Newcastle district it would mean a very large expenditure, which I scarcely think would be warranted by the circumstances. (*Applause.*)

**Mr. Mange**, Orleans Railway, France. (In French.) — I rise to speak for the same reason that induced Mr. Wilson to intervene.

Since the 1<sup>st</sup> of July last year, we have instituted electric traction on a portion of the Orleans railway, on the line between Paris and Juvisy. This installation was carried out after completely transforming this suburban line which is 20 kilometres (12·4 miles) long. Four tracks were laid down, two for express trains and two for the ordinary trains, mainly suburban ones, which are run by electrical power. The electric trains are either ordinary trains in which the steam engine is replaced by an electric motor or are reversible automotor trains with a motor car in front and behind; as regards loading, there are two types : heavy trains, weighing 250 tons, with seating accommodation for 1,000 passengers and light trains, weighing 175 tons, with seats for 550 passengers.

One point that has apparently struck Messrs. Wilson and Sullivan especially, is the

need to provide every possible convenience for passengers to get in and out of the cars. We use rolling stock with side doors which facilitates entry and exit; moreover, each train always comprises the same number of cars, situated in the same order and arranged so as to stop at the same point on the platform, so that the public know beforehand where they will find the first, second and third class carriages. Passengers can therefore get in quickly without needing to run along the train.

Moreover, the rapidity of the service is facilitated by using automatic catches which render it possible to open and close the inside doors of the cars by simply pushing them. By these arrangements, we have succeeded in limiting the stops in most cases to thirty seconds.

I have no intention of demanding your attention for long. I should however like to point out to you another interesting point regarding the economy of working expenses, arising from the installation of electric traction. We have been enabled to reduce our train staff by one individual; the motorman alone fulfils the functions entrusted, with steam traction, to the stoker and the driver. Of the two other train attendants, who are conductors, one sits on the locomotive beside the motorman or in a compartment communicating with the motorman's platform ready to take his place in case of accident.

The number of suburban trains per diem has been raised from 75 to 100 since the line has been electrified between Paris and Juvisy. The length of the line between the Paris Austerlitz station and Juvisy is about 20 kilometres (12·4 miles) in length, and this distance is covered in seventeen minutes by the expresses and in twenty-three minutes by the ordinary trains which stop at six intermediate places.

In the mornings and evenings, there are workmen's trains at very low fares; the single journey costs about 10 centimes (1 d.). (*Applause.*)

**The President.** — I should just like to allude to one point that the speaker mentioned. I think it should be understood that in England at the present time, and for more than a year past, there has been one large system of electrical suburban railway working, and that is what Mr. Alexander Wilson described to us just now.

**Mr. W. H. Hyde.** — There is also the Lancashire & Yorkshire, Mr. President.

**The President.** — I was only thinking whether that was strictly suburban.

**Mr. J. E. Charnley,** Lancashire & Yorkshire Railway, Great Britain. — It is purely suburban traffic between Liverpool and Southport.

**The President.** — This gentleman has pointed out that there is another installation of very considerable size between Liverpool and Southport. We do not wish it to be understood that there is no electrical work carried on successfully with suburban traffic in England.

**Mr. Brisse,** French Eastern Railway. (In French.) — I have no intention of

occupying much of your time. I should however like to give you in a few words the reasons why most of the French companies, most by concerned in suburban traffic, and especially the Eastern Railway, are maintaining an expectant attitude towards equipping their lines electrically.

So far these companies have not come across any valid reason for altering their method of traction and for adopting electricity; the only thing that would encourage them to do so is economy.

But if we take a piece of line exclusively devoted to a suburban service, we soon find that its traffic is one that has congested and very congested periods. It soon appears even that as this traffic grows, these congested periods increase proportionately more than the growth of the average traffic.

On the other hand, the economical working of an electrical power station depends upon its loading coefficient. If then we are to set an electrical installation apart exclusively for a suburban line, we should be induced to institute a source of power with a very low loading coefficient and badly utilized at first. The difference between this coefficient and what corresponds to the maximum output of this source of power is too great, and its first cost too high, to make us think that such a transformation can appear to be indicated for the exclusive use of a suburban line.

There is another stronger reason why some companies hesitate to introduce electric traction. On several lines, entering the heart of Paris or serving its immediate neighbourhood, it would mean expending large sums if the institution of electric traction meant a fairly marked increase in the number of trains run over these lines. Now, so far, we have not thought that the advantages arising from electric traction, from the standpoint of increase in the total capacity of each train run, have yet shown themselves great enough to represent a better utilization of the instrument, *i. e.*, an immediate and real increase in the capacity of the line itself. We find ourselves with a maximum traffic concentrated into a very brief period of the day and the line has not only to cope with this traffic but to carry twice as much.

I take by way of example, our little Bastille railway, which is a simple line with two tracks. During the hours of maximum traffic, *i. e.*, towards evening, we carry with steam traction over this line an average of 5,000 passengers per hour, in eight trains with a seating capacity varying from 1,200 to 1,400.

Now the highest figures with which I am acquainted for a train hauled by electricity, are those just quoted by Mr. Mange. According to him, the capacity of an electric train on the line between Paris and Juvisy is 1,000 seats. This is still not high enough to lead us to expect that electric traction would mean better utilisation of our line.

On the contrary, giving up our present method of traction for electric traction would bring us much nearer to the time which will show the necessity to which we shall doubtless come within a more or less distant future, of doubling our Bastille line.

If I have rightly understood the reports of Messrs. Drury and Sullivan, there are reasons of the same kind which have decided the English and American companies, directly concerned in suburban traffic, not to consider for the present the advisability of electrifying their lines.

From this standpoint, I should like further to ask Mr. Wilson the following queries : Before the electrification of the line in the Newcastle district, what was the maximum capacity of the suburban trains on that line, and what is their capacity now ?

My attention has also been caught by the recommendation appearing in Mr. Drury's report regarding the arrangement of terminal stations. We all know the importance of the terminal station arrangements from the standpoint of organising suburban traffic.

Mr. Drury advises the construction of a loop or circle at main terminal stations.

I should very much like to hear whether any arrangements of this kind have already been effected or projected on very busy lines, either in England or in America.

I have, in conclusion, one more observation to offer. Messrs. Drury and Sullivan have advised trains being run in parallel which involves necessarily laying down four tracks if it is intended to run trains of various speeds. I may remark that when a service is arranged on a single line with two tracks, the mingling of through and stopping trains does not always imply that this line will be less well utilized ; in other words, this admixture does not necessarily reduce the capacity of the line as compared with when only stopping and parallel trains are run upon it.

In this latter case, I believe that in case of parallelism, the average utilization per kilometre or mile of a train starting full from a terminus is only 50 per cent of its capacity. On the other hand, if the service is worked with stopping and through trains, we get with a through train, doing a good part of the journey without stopping, and starting from a terminus full, a much higher kilometric utilization and a better employment of the capacity of the sum total of the trains run. (*Applause.*)

**The President.** — Will Mr. Wilson kindly reply to that question, about the maximum number carried per train, before electrification, and since ?

**Mr. Alexander Wilson** — Of course, we have now a more frequent service than before, and consequently the maximum number carried in a particular train is less, than it hitherto has been. Hitherto we had perhaps an hourly service or a half hourly service. Now the trains run oftener.

**Mr. Brisse.** — I thank you.

**The President.** — In inaugurating this new electric service of yours, Mr. Wilson, was it not to compete with the tramway, and therefore you get a great many more trains than you had before, and the travel is divided between them.

**Mr. Alexander Wilson.** — The answer to that is in the affirmative, but as I have said we are regaining from the tramways a portion of the traffic which we lost to them under steam working conditions.

**The President.** — The other question is, whether the loop spoken of, to be established at the termini, to facilitate the rapid working of trains in and out, where there is an increased number of trains to be dealt with, — whether such a system has been applied and worked in England or in America.

**Mr. W. H. Hyde.** — Mr. Chairman, I am looking forward to a visit to Boston for the purpose of seeing the example of that loop at the Boston terminal, which, I understand, is provided with a subway line running around a loop. We had, in Liverpool Street, calculated to build such a loop, but it has not come yet. All our lines run into that terminus, engines come to the other end, and the train departs. We have about four minutes stop. That is very short, but we want to do better. We want to be continuous.

**Mr. Brisse.** (In French.) — Mr. President, I should like to know how many minutes trains stop at the Great Eastern terminal station in London at the rush hour of the evening before they are filled.

**Mr. W. H. Hyde.** — We could load it in a minute, so far as the actual loading is concerned, but we have to get a train in and out, and provide for an engine coming in, and the clearance of other lines.

We can work a train out of Liverpool Street, and another train crossing in three minutes. We tried two minute service, but we found it was not quite possible. We could load the train in a minute, but the longest time is consumed with the train getting in and out; that would occupy say three minutes out of four. Our average stop is only twenty-eight seconds at stations other than termini.

**The President.** — Perhaps some gentleman can tell us if that loop at Boston of which we have heard so much, and of which we have seen plans, has been in process of construction, or is working to day.

**Mr. A. W. Sullivan,** *reporter.* — Mr. Chairman, I have not been to Boston lately, but my understanding is that the loop referred to was built underneath the main floor of the train shed for future use. It has not been used. It is not intended to be used until the upper floor has reached its capacity. Then trains operated by electricity, suburban trains chiefly, will pass through the loop underneath the main floor, and steam trains will occupy the upper level.

**Mr. Mange** (In French.) — Allow me to point out to you an advantage of electric traction. On the Paris and Juvisy line, most of the trains are made up with motors at each end. Consequently, a train reaching a terminal station can start out again almost immediately. The stop only takes up so much time as is requisite for

passengers to alight and get in and for the motormen to pass from one end of the train to the other.

**Mr. Brisse** (In French.) — It is noteworthy that if electric traction possesses the advantage pointed out by Mr. Mange, loop or circular lines at stations would also offer with electric traction, a considerable advantage when the number of tracks meeting at a terminal station is great. For then the inconveniences inherent in outgoing trains crossing over a station to a track different from that by which they came in, get more noticeable and these would obviously disappear to a great extent, if the tracks were laid in a circle.

Obviously, it is possible to avoid some of the inconveniences and to cut down stops at terminal stations by putting a motor at the head and tail of the train. But this measure does not entirely abolish the inconvenience resulting from the fact that a train, arriving by a group of lines situated on one side of the station, must leave it by another group situated on another side.

**Mr. W. W. Hoy**, Central South Africa Government Railways. — **Mr. Chairman** and gentlemen, I should first like to express a sense of gratification for the complete and interesting papers which have been presented. In listening to the discussion it seems to me, that in dealing with suburban traffic, the problem presents itself as to whether that traffic can be moved more economically by the means of steam locomotion or electricity. We have two problems in South Africa : one in its nature similar to the suburban traffic which is dealt with in London, where there is an enormous pressure of traffic in the morning, at lunch time, and in the evening. The problem that confronts me is slightly different to this extent : that there is a suburban line, of sixty miles, and in addition to developing suburban traffic, which we are exerting all our forces to cultivate, we have, at the same time to maintain a regular traffic from early morning until late at night. Over a portion of the same suburban line, a very large volume, in fact the whole of the heavy goods traffic, has to pass. I have therefore considered, and the administration has faced the position in this way : that our policy is likely to be the attitude of getting out of a double line the utmost we can, before we think either of increasing the number of lines or providing four lines. The reason why we defer building additional lines is the hope of development in side tracks and by that means we shall still have our existing double line, and provide for the development which we look forward to. Therefore we have, to meet the present difficulty, reduce the load of our heavy goods trains in the direction of Johannesburg. Our passenger load is five vehicles, capable of accommodating in 1<sup>st</sup> class 64 passengers, in 2<sup>nd</sup> class 84 passengers and in 3<sup>rd</sup> class about 100 passengers. Figures have been worked out, and the administration is practically sure to electrify sixty miles of its lines, that is, practically thirty miles of its lines, that is, practically thirty miles on each side of Johannesburg, and thereby we shall provide for the expanding traffic which is induced in the mining areas. The Great Eastern problem, as it presents itself to me, seems to have been

to get the passengers into a longer train, maintaining expedition by providing heavier locomotives. I have not completely studied that phase of the question, but I have very carefully studied our position, and I think that the decision at which we have arrived, to reduce the trains, maintaining under the electric system our present load of five vehicles, with the possibility of increasing it to seven, will enable us to maintain a cheaper, more economical service, and at the same time, we shall be able to develop our traffic.

We have undertaken the development of short distance traffic through the aid of steam motor cars somewhat similar to the motor cars noticed in England and elsewhere. At a later date, we shall then face the position as to whether, when the traffic grows, it will be cheaper to adopt steam or electricity.

The other point I would like to refer to is the use of side door stock, versus the utility of corridor stock for suburban passenger traffic. Partly from the experience of others, and partly from local conditions, we resolved that our interests lay in adopting the corridor stock, and therefore all our suburban stock has a small corridor running from one end of the train to the other. It occurred to us that time is the greatest and most important factor, because we must reduce the service, to be successful, to the shortest limit, otherwise the policy of getting the utmost out of the line will be defeated. It that connection, I am glad to find that the ticket system is practically the same throughout our lines as adopted on the American lines, namely, to collect and check all tickets upon the trains while in motion. I have had some experience in dealing with the collection of tickets on the suburban line at Capetown, which has certainly not an insignificant traffic, and that experience convinced me that the government lost every month and every year not a considerable but an enormous revenue, by checking the tickets, or collecting them as the passengers left the station. Since our system has been introduced of collecting them on the trains, I think the substantial sum of something like £36,000 per annum is paid into the railway revenue, which includes a small fee collected from passengers who board the trains without being in the possession of tickets. I think I can say that the general opinion of our people is that the system is wholly satisfactory. All the opinion I have been able to ascertain, — and I have been anxious to collect it from all sources in our service, — has been in favor of the present system, and the recent managers who have joined our service from England have joined in that expression of opinion. I am very glad to hear from Mr. Wilson and from other gentlemen, that the electric system is a success and has provided for their requirements, because the programme in contemplation may be a little ambitious, but the discussion helps to assure one that when you reduce the consideration of the whole problem to figures, we shall succeed in being able to determine whether the principle shall succeed or fail.

For the information of the gentlemen here, I would state that our trains arriving in the morning, accommodate from 420 to 450 passengers.

One note sounded by Mr. Sullivan, of looking to the curves in providing for a

longer vehicle, has very much encouraged me, because our longest vehicle has been determined at 70 feet. Now I held the opinion previously, and I am very glad to have it confirmed, that with the *smoothing* out of that curve we shall be able to increase the capacity of our carriages to accommodate 100 passengers. I urged that phase of the question, but for various reasons it was not successful, and I think Mr. Sullivan has placed me in the position of returning to the recommendation.

**Mr. Brisse.** (In French.) — Allow me to ask whether power required for the lines round Johannesburg is supplied by a power house specially constructed for the railway, or whether it is bought from an electrical company of which there are some for working the gold mines in that district.

**Mr. W. W. Hoy.** — We consume a very large volume of electricity at the present time, supplied from two sources. We propose that the generating station shall be in a central position, convenient for the generation of electricity, and we propose to do the work ourselves, and our figures prove that we can do it much more cheaply than it can be supplied to us for the railroad and the lighting of the principal stations.

**Mr. Jenny,** Austrian Southern Railways. (In English and French.) — In the Austrian Southern Railways' suburban service, we used to have carriages with side doors, similar to what are used in England, but experience has proved that the American method, *i. e.*, cars with platforms and two end doors, is to be preferred for our business.

As I have said, the traffic on the Southern Railway is heavy, because it connects Vienna and Baden, Voslau and the Semmering. We have built some four-wheeled cars with platforms and doors at both ends, cars practically similar to the American ones on the New York Elevated Railroad.

We prefer this style of car to the carriages with side doors. It saves our having high platforms above rail level at our stations. Passengers have to climb up to get on a level with the floors of the cars.

Considering all these points, I should like to ask delegates who have had much experience, why they prefer carriages with side doors to carriages with platforms provided with doors at each end.

**Mr. A. W. Sullivan, reporter.** — Mr. President, that question goes to the root of the experience of the Illinois Central management in the handling of a traffic which has grown steadily throughout thirty years, and which, during the World's Fair held in Chicago in 1893, forced a development to meet the conditions obtaining there, that has brought the service to its present state of perfection, and put it considerably ahead of the other railroads in the country in the handling of a dense passenger traffic. The circumstances of that season of 1893 were these: the location of the site of the World's Fair with reference to the city made the Illinois Central the main avenue of steam railway transportation to and from the Fair grounds. It was

foreseen that the traffic would be very heavy, and it so proved to be, the railroad having handled during the short period of the Fair, upwards of 19 million of passengers. The requirements for handling a traffic of such density made the type of car one of vital importance. The question was very carefully considered with the result that the sliding side door car was adopted as the best form of car construction for the purpose. The use of this type of car made it possible for trains, each carrying one thousand passengers, to be either loaded or unloaded in ten seconds; the movement of the trains at the maximum of traffic being as frequent as five trains dispatched from one platform in four minutes, each train carrying one thousand passengers. To handle one thousand passengers, in ten seconds, either in loading or unloading, is getting down to a very satisfactory basis of service. Subsequently to the exposition of 1893, the company decided that in building new cars it would adopt the sliding side door principle, but it required care in construction to meet the requirements of the climate which, in winter time, is exceedingly severe. The problem necessitated a study of the whole question, with the view of making possible a winter car that could be operated with facility, and kept warm at the same time, in severe stormy weather. Careful study of that problem led to the conclusion that it was not possible of accomplishment with the wooden forms of construction, but that the results desired to be obtained could only be obtained through a metal construction, and when the problem was approached in that direction it rapidly took a definite shape, and has resulted in the design of a car that performs the service in a very satisfactory way.

There are one or two points of detail that I will allude to in this connection. What is the reason the side door car works more satisfactorily upon the Illinois Central than it has done upon other roads where side doors are in use, may be explained primarily by the fact that the sliding side door, when properly designed, is very much more effective than the swinging door, and can be more safely used. The sliding side doors of the Illinois Central cars are entirely under the control of the train guards and are worked by hand or by air, easily and with great smoothness. The locking mechanism can be operated only by the guards. The doors are not, however, opened simultaneously. They are unlocked, and the passengers are left to open them as they choose, from either the inside or the outside of the car. The reason for that arrangement is this : if there is only one passenger to get out at a station, it would be manifestly an absurd arrangement to open twelve doors to let out one passenger. Therefore it is arranged to have the doors released, so that they may be opened as they are needed to be used. The working out of that arrangement has been very satisfactory. The passengers have rapidly comprehended the situation, and have lent themselves to it quite readily. The main difference between the European car and the Illinois Central side door car is this : that in the European car with the swinging side door, there is no connection between the doors, and there can be no concert of movement, which is quite essential. Besides, a passenger ordinarily will not enter a compartment unless he can see therein a

vacant seat. The consequence is that the trains with that style of car have to stand at the platform a sufficient length of time for the passengers to find seats by going from one compartment to another, when the trains are partly filled, and that consumes a great deal of time. Upon the Illinois Central cars, as shown in my report, immediately within the doors of either side of the car is an aisle running throughout the length of the car, and connected at the ends with the other cars of the train, so that a passenger can enter at any one of the twelve doors and afterwards, after the train has resumed motion, can find a seat if there are any vacant in that car or the other cars of the train. There is just one more point relating to the expedition of the train movement and that is this : that under the Illinois Central system, the doors are all closed by the guard : by an easy movement of a hand lever or wheel, every door that is open is closed and locked, and the instant that is accomplished an electric circuit is completed by means of which the signal to start is automatically given to the engineer, and the train can with safety be started immediately. In this operation it is a matter of indifference whether there are two or twenty cars in a train ; the transmission of the starting signal to the engineer can thus be given only when every door in the train is closed and locked, and that is done without reference to the sequence of the use of the cars. For instance, the customary way of starting a train is by giving the signal by bell from the rear and passing it from car to car until it reaches the engineman in front, a method productive of much loss of time. By this side door system, every guard works independently of the others, and closes the doors of his car promptly when the passengers are unloaded or loaded ; the moment the signal is given to the engineman by the closing of the last door, that same instant the train may depart with the absolute knowledge that no one can either get on or off after the train has resumed its motion. Therefore the element of personal hazard is greatly reduced.

**The President.** — I think we have had a very full discussion on this question of suburban traffic this morning, and I would put before you here briefly a suggested resolution for your approval. I do not want to take a vote upon it this morning, but if no one raises an objection I would present it to the General Secretary which it is my duty to do, and then get it formally passed by the meeting at our next session :

“ The Congress approves the conclusions of the reporters as regards the working of suburban traffic. It has listened with interest to the descriptions given of the use of electric traction in England and in France, but is not prepared to recommend this system. ”

**Mr. Mange.** (In French.) — The Congress would appear to be condemning electric traction if we said that “ it is not prepared to recommend it ”. It would be better to say that the Congress is not in a position, at present, to choose between electricity and steam as tractive power. We should thus leave every management free to resort to whichever system suited it best.

**Mr. Félix Sartiaux, secretary.** (In French.) — In the ultimate wording of the conclusions, Mr. Mange's remark shall not be forgotten.

**The President.** — In connection with what has been said, I have altered it to read : " The Congress is not prepared to express its preference for electrical or steam power. "

**Mr. Brisse.** (In French.) — Do the trains carrying the suburban traffic on the Illinois Central convey luggage?

**Mr. A. W. Sullivan.** — No.

— The meeting adjourned at 12.30.

---

**Meeting held on May 8, 1905 (morning).**

---

**The President.** — On Saturday the members of the 3<sup>rd</sup> section were discussing the question of suburban traffic. I have here a resolution which was provisionally placed before them, and I bring it up for their approval this morning, according to the special arrangement which was made :

" The Congress approves the conclusions of the reporters as regards the working of suburban traffic. It has listened with interest to the descriptions given of the use of electric traction in England and France, but it is not in a position to express its preference for one or the other method of traction, steam or electricity. "

— These conclusions were adopted.

## DISCUSSION AT THE GENERAL MEETING

---

Meeting held on May 11, 1905 (afternoon).

---

MR. STUYVESANT FISH, PRESIDENT, IN THE CHAIR.

GENERAL SECRETARY : MR. L. WEISSENBRUCH.

ASSOCIATE GENERAL SECRETARY : MR. W. F. ALLEN.

Mr. H. Tylston Hodgson, *president of the 3<sup>rd</sup> section*, read the

### Report of the 3<sup>rd</sup> section.

(See the *Daily Journal of the session*, No. 4, p. 68, and No. 5, p. 87.)

“ Mr. W. H. HYDE (*Great Eastern Railway, England*) presented an abstract of Mr. H. G. Drury's report.

“ The characteristic feature of this service is the necessity of handling a very heavy traffic and making the necessary arrangements during a very short period of time every morning and evening.

“ The main points to be considered are :

“ 1° *The number of passengers to be carried.* — At the Liverpool Street terminus, the maximum round number of passengers arriving on an ordinary weekday is about 86,000.

“ 2° *Motive power.* — On the Great Eastern, single expansion engines with 4, 6 and 10 coupled wheels.

“ 3° *Train running, speed.* — On the Great Eastern, average speed for local trains, 19  $\frac{1}{2}$  miles per hour. Twenty-eight seconds stop at stations.

“ 4° *Signals.* — The block system is generally employed on the Great Eastern.

“ 5° *Station management.* — In order to distribute passengers as much as possible over a longer space of time, the Great Eastern has divided the first morning hours in the working class districts into “ time zones, ” the fares varying according to the hour at which passengers take the train. Special measures have been provided by the Great Eastern to avoid congestion in the case of fog.

“ Mr. A. W. SULLIVAN read an abstract from his report which was drawn up on the same plan as Mr. H. G. Drury's in order to facilitate comparison between the American system and that of other countries.

“ Mr. Alex. WILSON (*North Eastern Railway, England*) stated that his company has been operating for the past year a suburban service in the Newcastle district with electric power, with the object of regaining the traffic from the competing tramways and to increase its amount. Not all the traffic has been regained from the tramways, but the amount handled has been considerably increased. The reduction in expenses has resulted in a net revenue which more than covers the interest on the extra cost of installation necessitated by the introduction of the electric power. The current is furnished at a reasonable price by power stations which do not belong to the railroad.

“ Mr. A. MANGE (*Orleans Railway*) stated that his company operates electrically 12·4 miles (20 kilometres) on the Paris-Juvisy line, 100 trains daily instead of 75 as before the use of electric power. Four tracks are used, two for express tracks and two for locals. Trains are operated with reversible motors in front and behind. There are two types of trains : heavy trains, 250 metric tons (246 English tons) and 1,000 seats; light trains, 175 metric tons (172 English tons) and 550 seats. The labor of one man was saved; the motorman alone fulfilling the duties of the fireman and driver employed on the steam road.

“ Mr. BRISSE (*French Eastern Railway*) explained why the majority of the French railroad companies still adopt a waiting attitude as to the electrification of their lines. He showed how the mixture of express and local trains on the same line does not necessarily reduce the capacity of this line, compared with lines where local trains only are operated.

“ Mr. A. W. SULLIVAN stated that installations have been made at the terminal station at Boston, underground, for a continuous circular service. Reversible motor trains like those of the Paris-Orleans road reduce considerably the time required at the terminal between the arrival and the departure of the trains, but the arrangement of the tracks in loops insures a still more complete continuity, and avoids the inconveniences due to switching from one track to another.

“ The discussion finally turned to the various types of cars best suited to a rapid service. Mr. JENNY (*Austrian Southern Railways*) has experimented in the suburbs of Vienna, and has observed that cars provided with doors at both ends for the incoming and outgoing passengers give better results (the cars were emptied and filled in thirty to forty seconds). Mr. A. W. SULLIVAN, on the contrary, prefers side doors. The latter system has enabled the Illinois Central to accomplish the same operation in ten seconds, with a train carrying 1,000 passengers, and to send out on the same track five such trains in four minutes. The cars of the Illinois Central, in summer, are completely open and accessible to the public at all points at once. In the winter, a mechanical arrangement has been adopted enabling the conductor to open by one movement twelve doors, or a fraction thereof. In addition, the closing motion sets up an electric current which notifies the motorman at the head

of the train and permits the immediate starting of the train, with the assurance that all passengers are safely on board. These cars have vestibules connecting the whole train, and thus many passengers select their seats after entering the train.

“ The section adopted the following conclusions to submit to the general meeting. ”

**The President.** — The following are the

### CONCLUSIONS.

“ To be in the highest degree remunerative, the traffic must be handled rapidly, by simple and inexpensive methods, and with the minimum working organization necessary for the purpose; the type of car is the essential factor; new lines to be constructed should be adapted to the best types of cars; on old lines, the cars should be of such size as will utilize in the highest degree the space between tracks; [[the curves should then be compensated to provide the same clearances as upon tangents]] <sup>(1)</sup> the locomotives should be sufficiently powerful to haul trains of maximum size at the speeds required; the train schedules should provide for the movement of all trains at a uniform speed and stopping at all stations upon the same tracks; separate tracks should be provided upon lines of heavy traffic for trains which are run at high speed and do not stop at all stations; all necessary measures should be taken to accelerate the movement of passengers and start the trains promptly. In this way, the expenditure of energy required to regain time lost is conserved, and the promptness with which the service is conducted, communicates itself to the passengers, who quickly learn to move more rapidly; the frequency of train movements should be proportioned to the volume of traffic, to avoid prolonged waiting of passengers and congestion at stations.

“ The Congress has listened with interest to the descriptions given of the use of electric traction in England and France, but it is not in a position to express its preference for one or the other method of traction, steam or electricity. ”

**Mr. H. Tylston Hodgson, president of the 3<sup>rd</sup> section.** — The conclusions printed in the daily journal differ slightly from those that have been read.

The section approved the conclusions of the reporters with regard to the working of suburban traffic. The reporters' conclusions have simply been taken and reproduced at full length. That is the only difference.

**Mr. Cartault, Paris-Lyons-Mediterranean Railways. (In French.)** — The words “ the curves should be compensated ” would seem to imply that it was advisable to carry out alterations in the profile; but such alterations would be difficult and expensive,

---

(1) The words enclosed in double brackets were omitted in the final draft (*vide* the discussion below).

because suburban lines run through residential quarters, built in places where land is of great value. And there is no doubt, moreover, that as a rule the existing routes meet the necessities of the service.

I question whether it is not advisable to strike out the words "the curves should be compensated"?

**Mr. von Leber**, Austrian Imperial & Royal Ministry of Railways. (In French.) — The English is still less clear.

It is difficult to understand what is meant by : "compensating the curves". Do you want to alter the route of the railway?

**Mr. L. Weissenbruch**, *general secretary*. (In French.) — I suggest that we strike out :

"The curves should then be compensated to provide the same clearances as upon tangents."

**Mr. Mange**, Orleans Railway, France. (In French.) — I was present at the debate and I thought I understood that the section noted in a general way the reporters' conclusions, but that the only resolutions passed by the section were those that concluded the summary just read by our President.

**Mr. L. Weissenbruch**. (In French.) — That is not quite the case. It is stated "the Congress *approves* the conclusions of the reporters". If that stood in the conclusions to be passed by the general meeting, one would have to refer to the reporters' conclusions. The president of the section has just explained that he thought it preferable to pick out the conclusions approved and to insert them in full.

**Mr. Mange**. (In French.) — I thought all we did was to approve a principle, but that the section did not take over the reporters' conclusions individually.

**Mr. L. Weissenbruch**, *general secretary*. (In French.) — There is only one objection to the proposed text and that applies to the words "the curves should then be compensated, etc." and all we need do is to strike out that sentence.

**Mr. Cartault**. (In French.) — I should like to point out that the clearance's play depend upon the length of the vehicles and how they are constructed.

If you work a suburban line with cars 7 or 8 metres (23 feet or 26 ft. 3 in.) long. The play will be different if you use a bogie carriage. So then you would have to alter the plan of the line every time you changed the pattern of car, and that is impossible,

**Mr. L. Weissenbruch**. (In French.) — Everybody agrees to strike out these words. So the conclusions are adopted with the omission of these words.

---

4<sup>th</sup> SECTION. — GENERAL.

---

[ 656 .235 ]

QUESTION XIII.

---

**SLOW FREIGHT RATES**

---

*General principles and description of the different systems of rating slow freight goods.*

**Reporters :**

*America.* — Mr. M. C. MARKHAM, assistant traffic manager, Illinois Central Railroad.

*England.* — Mr. Harry SMART, secretary Railway Clearing House.

*Italy, Spain, Portugal, France and Belgium.* — Mr. A. MANGE, ingénieur, chef adjoint de l'exploitation de la Compagnie du chemin de fer de Paris à Orléans.

*Other Countries.* — Mr. W. J. VAN OVERBEEK DE MEYER, chef de la division des tarifs à la Compagnie pour l'exploitation des chemins de fer de l'État néerlandais.

---

## QUESTION XIII.

---

## CONTENTS

---

	Pages.
Sectional discussion . . . . .	1713
Sectional report . . . . .	1734
Discussion at the general meeting. . . . .	1734
Conclusions . . . . .	1740
Appendix : Note on the freight rates on the Indian railways, by William A. DRING .	1741

### PRELIMINARY DOCUMENTS.

Report No. 1 (England), by Harry SMART. (See the *Bulletin* of July, 1904, p. 573.)

Report No. 2 (Italy, Spain, Portugal, France and Belgium), by A. MANGE. (See the *Bulletin* of January, 1905, p. 209.)

Report No. 3 (other countries), by W. J. VAN OVERBEEK DE MEYER. (See the *Bulletin* of March, 1905, p. 1169.)

Vide also the separate issues (in red cover) Nos. 2, 25 and 39.

---

## SECTIONAL DISCUSSION

---

Meeting held on May 5, 1905 (morning).

---

MR. ÉMILE HEURTEAU, PRESIDENT, IN THE CHAIR.

**The President.** (In French.) — We shall now take up the first question on our agenda paper concerning “ the rating of slow freight goods ”.

Four reporters were appointed : Messrs. Harry Smart, Mange, W. J. Van Overbeek de Meyer and M. C. Markham.

Mr. Markham has not sent in any report. But we have received reports from Messrs. Harry Smart, Mange and W. J. Van Overbeek de Meyer.

I beg you to notice that the subject falls into two headings : the general principles of rating and the description of the different systems of rating slow freight goods. I think you will agree with me as to the unadvisability of entering upon a discussion on the different systems of rating which have been described and discussed in a most alluring and thorough manner by the reporters. We will limit our debate to the general principles, ignoring the details which have been very fully expounded in the reports to which we can all refer.

Mr. Lewis Wood will now give us a summary of Mr. Smart's paper.

**Mr. Lewis Wood,** Railway Clearing House, Great Britain. — I must apologize for Mr. Smart's absence, but unfortunately he is unable to be here, much to his own disappointment as he had made all preparations to come. I therefore lay on the table for him the report which he has carefully prepared and which has been submitted to, and approved by, the various companies who are parties to the Clearing House.

It must be borne in mind, Mr. President, that the Clearing House exists primarily for the purpose of dividing the receipts from the traffic carried by and exchanged between the various railway companies, and that the question now before us is, so far as the Clearing House is concerned, a secondary one; consequently, Mr. Smart, to be certain of his ground, has had recourse to the railway companies for confirmation of some of the various points. The information given in the report may therefore be taken as absolutely reliable.

All the railroad companies of the United Kingdom of Great Britain and Ireland were created by Act of Parliament which fixed the maximum freight charges which the companies might make for transportation. The tariffs which companies were previously authorized to establish, were not uniform because of the different acts under which they were organized. As classifications of merchandise were relatively few in number, many incongruities resulted. In 1881, the House of Commons appointed a special commission to make an investigation regarding the traffic of railroads and canals. This inquiry resulted at first in the Railway and Canal Traffic Act of 1888, and then as a result of new petitions and suggestions from the companies, in the Laws of the Railway (Rates and Charges) Order, Confirmation Acts of 1891 and 1892. These acts established, firstly, a general classification of the various classes of freight; secondly, the maximum limit of supplementary charges; thirdly, the maximum rate of transportation per ton-mile for each class.

In addition to the official classification, the companies have deemed it useful to publish a working classification corresponding to the charges actually made. Also with a view of encouraging the development of business, the companies have made special rates lower than the regular tariff, based on the earnings per car-mile and terminal expenses.

In some cases, tariffs have been especially reduced for large movements of freight between given points during a certain period.

In making any special rates, the companies are not permitted to discriminate between shippers. No distinction is made in the tariffs as regards the time within which the goods are to be delivered, but for many articles, lower rates are made for special conditions which relieve the operating companies from responsibility as to losses, damages, mis-delivery, delay or detention, except in the case of wilful misconduct on the part of the railroad companies' employees.

Any tariff objected to can be submitted to the Board of Trade who are empowered to endeavour to bring about by conciliation a settlement of the dispute, and failing this may give the objector a certificate authorising him to bring the matter before the Railway Commissioners who can decide the case.

The Board of Trade has no power itself to fix or to modify tariffs.

**The President.** (In French.) — We learn from Mr. Smart's report that the rates in England are fixed by the operating companies, but with right of appeal to the railway commissioners if a dispute arise.

Now we come to the second report by Mr. Van Overbeek de Meyer. Has anyone been authorized to represent him? If no one is taking his place, I shall ask Mr. Mange to be good enough to give us a summary of Mr. Van Overbeek de Meyer's report, which we have all read with great interest, along with that of his own report.

**Mr. Mange, reporter for Italy, Spain, Portugal, France and Belgium.** (In French.) — Mr. Van Overbeek de Meyer's report deals with all countries except the United

States, England, Italy, Spain, Portugal, France and Belgium; it therefore covers an immense number of railway systems. It is extremely interesting, but also very voluminous. I can therefore give you only a very short and very imperfect summary of it.

In the first portion of his report, Mr. Van Overbeek de Meyer considers the rating of each country individually. There are in this first portion some exceedingly interesting points about the general principles upon which rating is based.

Mr. Van Overbeek de Meyer has not, however, limited himself to dealing with the rating in countries belonging to the Congress; he has, quite rightly, indicated the principles of the German rating and one of the features of his report is the very interesting data about the basis on which this rating is based.

Mr. Van Overbeek de Meyer shows that in so far as the German rating is based on the value of the goods, it does not take into consideration only their market price, but also the requirements of the various industries, according to their position at the time, the amount of protection they need, etc.

Besides the normal tariffs of the German railways, there are special tariffs suited to needs of various kinds, as for instance the tariffs instituted to meet the competition to which the railways are subjected, to assist certain national industries, to encourage the export and import of certain products.

The principles upon which the rates are based in Austria are very similar to those applying to Germany. Goods are rated according to their actual value, but the weight and bulk are also taken into consideration. It may be said that the system takes into consideration also the economic requirements, the financial position of the railways, and the systems of rating adopted by adjoining countries.

In Hungary the principles are much the same. In applying them, there exists the peculiarity that the charges are not set out in scales based on kilometric distances; they are fixed by zones of 10 kilometres (6·2 miles), and the charges instituted for the average distance of each zone apply for the whole of this zone.

Mr. Van Overbeek de Meyer thus passes in review the various tariffs in the States with which his report deals. In order not to weary you by going on too long, I think it better to draw your attention at once to the main conclusions of his report.

In the countries with which Mr. Van Overbeek de Meyer is concerned, we find as the fundamental basis of rating, what he calls the mixed system, based on the one hand, upon the value, and on the other, upon the weight and bulk of the goods. In this mixed system, it is always the value which is the predominating factor, especially the actual value at the arrival point, influenced by water competition or by commercial considerations. The effect of the tonnage makes itself felt in the difference of rate which there is between broken loads, on the one hand, and truck loads on the other.

The number of classes of goods used as a basis in applying rates for conveyance varies in each country. There are usually a certain number of classes for broken loads, be it one, two or three, and a certain number of classes for truck loads; 6 in

Germany, 6 in Austria-Hungary, 3 in Bulgaria, Holland and Denmark, 5 in Switzerland, 9 in Sweden, 11 in Norway, 13 in Russia which possesses the greatest number.

Austro-Hungary is the only country that makes the rate for truck loads vary according to how the goods are packed. Goods packed in a way other than that specified in the tariff are charged the rate one class higher than their natural class.

The kind of rolling stock used plays an important part everywhere in that for many goods the class of rolling stock employed affects the charge for carriage. From this standpoint we may distinguish between two classes of goods : those naturally conveyed in closed wagons or in trucks sheeted by the railways, and those naturally carried in open trucks.

In the first category are usually placed small goods ; in the second category, goods of little value, crude materials, etc. For these latter goods, consignors can demand covered or sheeted wagons, but if this is done the rates of the corresponding class are raised, the amount varying according to the system concerned.

Mr. Van Overbeek de Meyer goes on to say that as regards the relations between the railway managements and the Governments, it may be admitted that the different normal tariffs considered in his paper have a legal character, in so much as they are issued by the Government itself or confirmed by it. In some instances, however, a few exceptional tariffs are not submitted for governmental approval.

Mr. Van Overbeek de Meyer next considers exceptional tariffs which comprise rates lower than the normal tariffs.

He distinguishes between two main groups of exceptional tariffs : those which are of general application and those which only apply to certain relations or to the transport of certain goods. The reasons for making these exceptional tariffs are many, and they vary according to the requirements of the traffic, and the economic or geographical situation of the railway lines.

We may instance more especially special export and import tariffs, transit tariffs, tariffs for the development of national industry and commerce, tariffs to favour certain needs of a general character, to meet the competition of waterways or of other home or foreign railways.

In looking at the principles upon which they were established, special tariffs in general, and even those of a country taken individually, vary considerably in their bases. Sometimes tariffs arise by simple declassifications, others grant reductions of so much per cent on the usual rates. Others again give simply fixed rates adjusted according to competitive tariffs.

In concluding, Mr. Van Overbeek de Meyer asks himself whether it would be possible to arrive at a method of uniform rating, at least of making the general principles uniform. He is at first disposed to answer this question in the affirmative when he considers only the general principles, but he subsequently observes that it is not so much a question of principles in general as of the way in which they are applied in the different countries. This way of applying them varies so much that it seems impossible to arrive at a uniform system.

The greatest difference lies in the various classifications and in the unit rates. These classifications and rates are so much affected by the national and local requirements, by the demands of industry and commerce, by the geographical situation and by the competition, depending on them. that it may be asserted that every country has the tariffs specially suited to it. Consequently, no railway can give up its existing system without very seriously affecting the national interests and without failing to fulfil the great functions it carries out in modern economy, functions which have the double object of developing, on the one hand, national production in all its forms, while at the same time extending the market for the different produce and on the other, of ensuring the pecuniary advantages which result from the development of traffic.

**The President.** (In French.) — I now call upon Mr. Mange to be good enough to give us a summary of his own report.

**Mr. Mange.** (In French.) — The report which I have the honour of bringing before you begins by recalling a few preliminary ideas as to the extreme limits between which the rates for carriage may lie. These limits are first the value of the transport, *i. e.*, the additional value an article acquires when it is conveyed to a place where its selling price is higher and, secondly, the net cost. The latter may itself be regarded from two different points of view, according to whether we mean the average net cost, *i. e.*, the whole capital charges and working expenses divided by the total number of traffic units, or whether we mean the actual cost of a given piece of work, which, in this case, only has to stand the expenses actually involved in carrying out this transport, the capital charges and working expenses being supposed to be already covered by the whole of the pre-existing traffic. It is between these two limits, value of transport and net cost, that the rate may assume a whole series of different values.

When we come down from the highest limit and when we decrease the rate, the receipts rise at first together with the tonnage; but if we continue to lower the rate, there comes a time when the receipts reach a maximum and then fall to nil when the rate becomes nothing. On the other hand, expenses rise, I do not say proportionately to the tonnage, but as the tonnage increases.

It will be seen then that there is a rate at which the profit of the carrier, *i. e.*, the difference between the earnings and the expenses, reaches a maximum. If the carrier is acting on business principles, this is the rate, producing the maximum profit, that must obviously be sought after.

It should be noted that the rate which procures the maximum profit towards which the carrier ought to strive, if he is acting on business principles, is not the highest possible; very much the contrary, because as the rate falls and the tonnage of goods carried rises, the net cost of this transport effected in wholesale quantities falls also; consequently, it becomes possible to grant a further reduction of rate and thus, while the carrier gets the maximum profit, the traffic can be

developed as far as the general welfare of the community demands that it should be.

In reference to this, I recently read something very interesting in Mr. Hill's evidence on the rates question before the United States Senate. He stated that he had instituted on his system a rate for the carriage of timber which I believe, considering the small amount originally carried, meant a loss. But this traffic grew so enormously without any proportionate increase in expenses, that now it leaves him a good profit.

This point is important because people have often criticized the phrase "charging what the traffic can bear" and said it led to making almost prohibitive rates. That is quite a mistake. Charging all the traffic can bear, does not mean charging for an individual thing a rate just below what would prevent any being carried, but charging a rate which allows the traffic to grow to an extent that will give the carrier the maximum profit.

After this preliminary exposition of principles, my report states that the preceding theories are not exactly applicable in practice, because we cannot determine in advance the value of all items of transport, as this value alters constantly owing to the reaction which the various points of consumption and production exercise upon each other, and because neither do we know the law according to which traffic grows when we lower the rates. When it is a question of establishing a system of rates, we then have to give up these theoretical considerations and accept more practical methods of rate-making. But what has gone before suffices to show — and this is a very important point — that rating is not a matter of a formula but of circumstances, and that a rate investigation involves from the commercial departments special attention, and a thorough acquaintance with the requirements that have to be met in each case.

Next the report considers the origin and principles of the various systems of rating employed in the countries considered in the report, *i. e.*, by France, Belgium, Italy, Spain and Portugal. We state that at the commencement, except in the case of Belgium, where the railways have been worked by the State from the outset, the rates were fixed by the charters given. These rates were maxima and naturally could not be arranged in consideration of the value of the service, which would have involved making an infinitude of charges; something simpler was necessary and a system was instituted of classifying goods according to their market value into a certain number of classes, and applying to each of these classes a rate proportional to the weight carried and the distance run.

The railway companies, once their lines were built, had to get their traffic, in other words they had to fight the preexisting methods of transport, mainly cartage. In these circumstances, they were led to charging similar sums to those asked by the preexisting undertakings, that is to say in most cases station to station rates, taking into consideration the value of the transport.

The Belgian railways found themselves in a different position. As Belgium was honeycombed with waterways of old standing in every direction, the railways were

competed with to all parts by some navigable route. The circumstances were thus absolutely uniform, and it is on this account and copying navigation, that the Belgian State railway administration was led to making extremely simple rates, based exclusively on the capacity of the wagons and the distance goods were carried.

When subsequently railways had to lower their charges and come nearer and nearer to net cost, they were naturally obliged to insert in their rates conditions likely to reduce this net cost. Gradually all the rates in all countries contained conditions of this character which my report reviews. I do not wish to dilate much upon this subject lest I should so delay the discussion and I shall confine myself simply to recalling the main conditions.

In the first place, tonnage. It is quite natural that a reduction should be made for consignments in large quantities, because in this case the expenses of the carrier, per ton, are far lower than those caused him by the carriage of a retail quantity.

Secondly, the length of haul is obviously a factor which causes the net cost of carriage to vary. This induced many railway managements, following the example of Belgium, to make rates based on the differential system, *i. e.*, that the charges per kilometre fall as the distance increases.

Thirdly, accessory operations, such as unloading and loading, involve great expenditure to the railways, so much so that they were led in certain cases to grant reductions in charges, it being agreed in exchange that this extra work should be done by the consignee and the consignor themselves. Some railways even, such as the French Northern, went still further in this direction and made special reductions in rates for consignors who themselves made out way-bills, who shunted and marshalled the trucks at the point of departure.

Similarly, I might likewise mention the facilities afforded in the rates : 1° to owners of private wagons, because they save railways a large expenditure of capital; 2° the manufacturers who are content with very little time for loading and unloading, and who thus do not keep the company's rolling stock standing idle long; 3° to owners of private sidings who often obviate railways having to enlarge their plant.

Another factor in net cost and not the least important, is the extent of the carrier's liability. By common law, railways are subject to certain conditions of liability in case of delay, loss, damage, etc., and this liability involves expenditure often to considerable amounts. It is very natural and also quite legitimate that railways should have tried, in return for reductions — at times quite large reductions — to contract out of this liability and its results wholly or partially. I maintain that this procedure is very natural and quite legitimate and yet it has given rise to severe criticism in some countries. In France particularly, the law has lately been altered so as to prevent the railway companies contracting out of their liability for damage in consideration of a reduction in rates. On the other hand, in every other country, I believe, judging at least from Mr. Van Overbeek de Meyer's, Mr. Smart's and my own reports, this is allowed.

I have now run over the main conditions to which the special rates of railways are usually subject, with a view to reducing the net cost of carriage. This is indeed a factor which, as I have said, deserves very serious consideration.

Nevertheless, we must not exaggerate its importance; and, as people have tried to do and as people have often demanded should be done, we must not make rates solely based on cost price. Such a system of rating would doubtless only bring about deplorable results from the standpoint of developing traffic. This is easily understood because the consignor is ready to pay for carriage the price it is worth to him, but not the price it costs the carrier.

Secondly, this system of rating, which is sometimes demanded on grounds of equity, would not be equitable at all, because, as I have said, it is impracticable to determine precisely the net cost of each piece of business. Only an average net cost can therefore then be arrived at, and it does not take into account the individual circumstances of each transaction, and consequently it has no real relation to the service actually rendered.

No system of such a kind could be accepted, except by a State railway agreeing to carry goods at a price far below the average net cost and charging the difference to the tax-payer. I need not discuss such a system here, but simply state that it has not been adopted by any State railway. This is why these railways, despite their special tendencies have, like the private companies, as a matter of fact based their rates much less on net cost than on the value of the transport; and they have even laid more and more stress on this latter consideration, by diversifying their tariffs more and more. They began with a system of exceedingly simple rating, based chiefly on the tonnage of consignments, on carriage in closed or open wagons, and little by little, the number of their special and exceptional tariffs multiplied until now they have attained an extraordinary development. Thus it happens that in Germany, more than half the total tonnage of goods is now carried under the conditions of exceptional tariffs.

It is to be noted that inversely, the private companies, which at first based their rates mainly upon the value of the transport, by instituting especially station to station rates, are more and more disposed to substitute for them scale rates. This latter system of rating has certainly much to commend it from the standpoint of clearness and simplicity; but it is certain that these characteristics are only secondary, and that the prime object to attain is above all the development of the traffic. Consequently, while instituting scale rates when that can be done, we must not hesitate to have recourse to station to station rates based on the value of transport, whenever it is the only means either to encourage traffic that would not otherwise exist, or to allow a railway company to get its share by fair means of a traffic that is already using other means of transport.

Such, gentlemen, is the summary of the main points in the first part of my report.

With regard to the detailed examination of the rates in each country, you will

find in the second portion of my report, the data which I have collected on the subject; I cannot summarize them, in view of their character, and I already owe you an apology for having taken longer over my summary than I had intended.

**The President.** (In French.) — We have now listened to summaries of the three reports submitted for our consideration; they describe the systems of rates instituted in all countries except in the United States, for which no report has been submitted.

Perhaps one of our American colleagues would kindly tell us upon what principles American rates are based. Our subject would thus be complete and we shall then have passed all the countries in review.

Would Mr. Hudson kindly tell us what classification is adopted for goods in the United States, if there are any rates analogous to what we in Europe call general rates, with special and exceptional rates and how they are fixed? As regards this latter point, I believe, in the United States, the rates are arranged even more than anywhere else upon business considerations, *i. e.*, by trying in each instance to fix the rate most suitable for developing traffic as much as possible and attract to the railways all the tonnage they can get.

**Mr. Stuyvesant Fish,** Illinois Central Railroad. — I think Mr. Hudson will be very glad to make what might be called an extemporaneous answer to the questions.

**Mr. T. J. Hudson,** Illinois Central Railroad. — I have not attended all these meetings, but have listened attentively to what has been said to-day by the different speakers, and shall be pleased to answer the questions asked by the President.

Our tariffs and classifications are largely based on the same conditions as mentioned in the reports submitted by the representatives of other countries, *viz.*, as to weight, bulk, cost, liability for damage in handling shipments, perishable or otherwise, fast or slow time schedules required, etc., all of which conditions enter into the cost of handling traffic.

It goes without saying that in the older countries matters have reached more fixed conditions than in the United States, so that the necessity of constantly changing tariffs and classifications does not exist to the same extent as with us.

The United States being a comparatively new country, as new railroads are built and the country settled up, developments are constantly being made in the matter of production of raw materials, which in turn opens up manufacturing interests, and coming in competition with that of other territory already engaged in same classes of business, makes constant changes in the matter of rates and classification necessary.

We make low tariffs on coal, lumber and other similar classes of carload freight; in addition to which, we have what are called commodity tariffs made for the purpose of building up manufacturing interests and these tariffs probably change more often than the others. Then there is a tariff on general merchandise shipments.

covering a large number of articles divided up into classes, the rates being made in accordance with cost of article, bulk, etc.

The question of competition, railroad and water, has also much to do with the making of our domestic rates.

Another feature to which I wish to call attention is that of import traffic, and which is quite difficult to handle; for instance, I have in mind some sulphur mines in the State of Louisiana, which have developed in the past few years, and the competition we have to meet on that business is from Sicily. To arrive at satisfactory rates from Louisiana to points in the United States, we have to ascertain the cost of production of the sulphur in Sicily and Louisiana, also the ocean and inland rates on the shipments made from Sicily to points of destination in this country, and then fix the rates from Louisiana to compete with same.

I merely mention this to show how far reaching the conditions are in making rates on import traffic.

The gentleman here suggests that I say something with regard to the Interstate Commerce Act :

The main features of that act are that no shipments can be moved until the tariff has been filed with the Commission at Washington and also posted for public inspection, and this is done by placing them in the Station Agent's office. These interstate tariffs cannot be changed without first giving the Commission five days notice in case of a reduction and ten days for an advance in rates.

The railroad companies have the right to make interstate rates, but they are subject to decision of the Commission on complaint of shippers, who may claim that they are unreasonably high. The decision of the Commission, however, is not final as the railroads have further recourse by taking an appeal to the courts.

**Mr. Mange, reporter.** — Must the tariffs be published ?

**Mr. T. J. Hudson.** — They must be published.

**Mr. Mange.** — In advance ?

**Mr. T. J. Hudson.** — Yes sir, they must be published and posted. Taking into consideration the vast interstate traffic of this country, comparatively few complaints have been made by shippers to the Commission, and the decisions in favour of the railroad companies, taken as a whole, have been more favourable than otherwise, and in some cases the decisions of the Interstate Commerce Commission, when unfavourable to the railroads, have been reversed by the courts.

**The President.** (In French.) — We are much obliged to our colleague for his exceedingly interesting discourse.

**Mr. James Douglas, El Paso & Southwestern Railroad, United States.** — Mr. President, there is another question upon which I think Mr. Hudson might say a word, that is in regard to State legislation in the matter of regulating rates and the power

that the States have to determine the rates within the States. Perhaps Mr. Hudson would like to supplement his remarks by saying something along that line.

**The President.** (In French.) — That seems to me outside our agenda paper; we are not entitled to discuss here questions of legislation, but only the principles upon which rates are based. Questions connected with legislation depend upon the varying circumstances of each country. It might be interesting to make this the subject at one of our future sessions. But at present the subject on our agenda paper is confined to the consideration and discussion of the principles upon which the rates in the different countries represented here are actually based.

**Mr. William d'Eichthal,** Local Railway of the Landes District, France. (In French.) — In America itself, it would seem that some States have a right to control and even fix companies' rates. It would be interesting to have precise particulars.

**The President.** (In French.) — That is not the question we have to discuss.

**Mr. Stuyvesant Fish.** — I would say that if that information about State legislation and other legislation in this country is of any interest to any of the members, the information would be gladly furnished. There is a committee of Congress now sitting dealing with this subject, and that information can be furnished. I should be glad to furnish it, but in view of the ruling of the chair upon the subject, of course I will not go into it. However, the reports on that can be furnished. I would add one thing in the way of explanation of what Mr. Hudson has said. As far as the complaints against the railways not having been sustained by the Commission is concerned, there is an appeal from the decision of the Commission to the courts, finally in this country. I would also add that there are exceedingly few cases of excessive rates which have ever been passed upon by the courts unfavourably to the railroads; I think there are only two or three such cases.

**Mr. T. J. Hudson.** — I think I mentioned that fact.

**Mr. T. H. Bendell,** Great Western Railway, Great Britain. — The important point in connection with the fixing of rates on English railways, as Mr. Smart has pointed out in his paper, is that very great attention is paid in England to undue preference. Now, it sometimes happens that in order to get the traffic, where there is water or other competition, it is necessary to fix very low rates. The Railway and Canal Traffic Act, passed in 1888, provides that a railroad company may charge a lower rate for a longer distance when the traffic is carried over the same route. But in that case the onus of showing that the rate is not an undue preference lies with the railroad company. Now, in practice it works out a little awkwardly. Taking the Great Western Railway, for instance, we have a very long line through Devon and Cornwall, with the sea-board on either side. If we wish to carry traffic at all we must carry it at very low rates indeed. It is not necessary to carry it at such low rates to Bristol or Exeter — say Bristol, for example. I could, for instance, get the traffic

at say 10 cents, but if I quote that figure it would be lower than intermediate rates, and there is always the fear of being taken before the Railway Commission and having the onus on myself of showing that that is not an undue preference. I would like to know whether in America there is any similar law, or whether the American railroads do quote rates regardless of distance over the same route lower than rates to intermediate stations on the same descriptions of traffic.

As an example, I quote traffic between London and Penzance, 326 miles. To get the traffic, I offer to quote a lower rate than I do to Bristol, which is 120 miles, because there is a sea competition the whole way. If I quote a low rate, I may be brought before the railroad commissioners on a charge of undue preference and have to justify what I have done. The fear of that is frequently a deterrent in quoting low rates, because if one loses the case, *i. e.*, if it be decided that one is not justified in doing it, one is liable for damages.

I should add that to get to Penzance, the traffic has to pass through Bristol.

**Mr. Stuyvesant Fish.** — May I ask you, Mr. Rendell, whether your law is positive, that you cannot carry in that case from Penzance to London through Bristol, and whether it takes into account the circumstances...

**Mr. T. H. Rendell.** — We may, the act says we may.

**Mr. Stuyvesant Fish.** — But the burden of proof is on you?

**Mr. T. H. Rendell.** — If anyone challenges it the onus of proof that it is not undue preference is on us. In the ordinary law, if a trader complains of undue preference, the onus of proof is on him, but the fact of your carrying the longer distance at the same rate over the same ground, throws the onus of proof on the railroad company.

**Mr. Stuyvesant Fish.** — The law, as I understand it, in England is, as Mr. Rendell has said, that the railway may carry from A to C through B, but then the burden of showing that that is not a preference is on the railway company. In America, the law is a little different. The law is that we may not charge more for a short haul, A to B, that being included in the long haul, A through B to C, than we charge A to C; but our law says "under substantially similar circumstances", and we do not have to prove quite so affirmatively as you do the difference of the circumstances. Am I not right, Mr. Hudson?

**Mr. T. J. Hudson.** — Practically, yes sir.

**Mr. Stuyvesant Fish.** — There has been a great deal written on that and decided by our courts here in the last eighteen or twenty years. That is substantially the difference, it is rather a difference in the words of the statutes.

**Mr. Lewis Wood.** — Might I ask if Mr. Rendell's question, which is one of great importance as affecting England generally, will be placed on the records of these

proceedings with the answer — because England will be very glad to know through this section what the decision is.

**The President.** (In French.) — Yes certainly, for the shorthand report will be published in full. — The subject before us appears to me to have been very thoroughly threshed out. Does anyone wish to speak?

**Mr. Le Grain, French State Railways** (In French.) — I desire to speak solely to observe that in the various speeches that have been made, no one has perhaps laid enough stress on the fact that the railway service is a public one, a characteristic generally recognized throughout the world and which necessarily leads to the principle of equality of treatment. This principle ought to form one of the bases of rate-making concurrently with those founded upon the value of transport which have been more especially considered by **Mr. Mange** in his report.

When we come to drawing up the conclusions of to-day's discussion, I trust our President will, if no one objects, take into consideration this observation which I have just briefly made.

**Mr. William A. Dring, East Indian Railway.** — **Mr. President**, I come from India, and very little, — in fact, I think, nothing, — has been mentioned to-day about Indian railways. Until recently Indian railways were seldom heard of. During the last few years they have profited very largely by experience gained. Indian railway men have visited England and America, and certain other countries, and we have come more to the front; and now I think we are of sufficient importance to make it convenient to state to you some of the conditions on which our tariffs are based. We, of course, coming from our great parent England, in the first place based our rates very much on the English practice. But as we have gone on we have departed in several instances from those rates. The principal departure has been that in addition to our maximum rates, above which we may not go, we have minimum rates below which we may not go. Now, that, I think, is a feature more or less peculiar in railways. That is to say, that we being to a large extent owned by the government of India, the government has found it necessary, in order to secure its interests, and that it shall have a fair return on its capital, to say to those of us who are working its railways: "You shall not charge below a certain rate, which is specified."

This rate was fixed probably fifteen years ago. Since that time, Indian railway traffic has more than quadrupled, and in its growth, and in, as we hope, the importation of efficiency into its management, the cost of working has greatly decreased. Our position at the present moment is that, in the case of the larger railways, we are now, on probably the majority of our traffic, charging the minimum rate which the government says we may charge. Some of us, while charging this rate, are bringing to the government and earning on the capital invested, something like 7 or 8 per cent per annum. We, having found that with these

low rates our traffic has increased in this enormous proportion, should like very much to be given further power. That is to say, we, having proved, as we hope, that we are duly careful of government interests, and consider the government as the predominant factor, would like the government to give us free control as to reduction of rates — as I understand practically every other country represented in this room has that power — at any rate it should give us the power of going below our present quotations. At present on coal carried long distances, and on wheat, we are charging less than  $\frac{1}{2}$  cent per ton-mile. I give you the information in American terms, as we are speaking in America. And referring to the gentleman who spoke on behalf of the Illinois Central Railroad (Mr. Hudson), he drew our attention to the circumstances that in the case of sulphur, the Illinois Central Railroad has to make its calculations on sulphur imported from Sicily. We have the same condition in India in regard to another commodity. In the last two years, India has come forward as a wheat exporting country. In 1904, India was the second exporting country to the United Kingdom, and in arriving at that position has been greatly assisted by its system of low rates. I should like India to be the principal exporter to the United Kingdom, but we cannot cut down another cent a ton unless our powers as given to us by the government are increased. So the reason why I have risen is to ask of you whether it is your opinion that a minimum rate should be laid down, as well as a maximum rate?

Then I would like to make a remark about the differential. That is a rule Mr. Rendell referred to as to charging from A to C a rate lower than is charged from A to B. Our rule is based on the English rule. We undoubtedly do quote lower rates from A to C than are quoted from A to B, but although we have a railway commission, constituted on exactly the same lines as that in England, there has never been a case brought before them complaining of consequent inequality of treatment. That is, no complaint has been made that we have injured one body of traders by charging a lower rate A to C, than on that from A to B.

As soon as I had an opportunity of perusing Mr. Smart's and Mr. Mange's and Mr. Van Overbeek de Meyer's reports, I thought it might be interesting to other railway lines, to know how India is progressing, and I prepared a short paper which my Board of Directors in England submitted to the Congress. It arrived too late. What I would like to ask is, whether under the exceptional circumstances this paper might be accepted now as a part of this morning's proceedings, so that those who care to peruse the same may do so.

**The President.** (In French.) — The interesting note that Mr. Dring has referred to will be added to the shorthand proceedings. (*See the appendix.*)

Mr. Dring tells us of an individual instance of companies that want to reduce their rates below the minimum and are not allowed to do so. As a rule, people want to lower our rates and we protest. Mr. Dring's is a peculiar case with which we are not familiar, and it is very interesting to hear of it.

**Mr. William A. Dring.** — That is why I ventured to make a few remarks.

**Mr. Stuyvesant Fish.** — Are not those minimum rates put in on account of the government ownership of the railroad?

**Mr. William A. Dring.** — Yes, sir. And they were necessary in the first instance, but now they are no longer necessary. They were so fixed, because when Indian railways first started, the government was afraid of meeting a great loss on their working. But those conditions are now changed. As a whole, the railway system in India is returning a considerable percentage on the capital invested. In this, I submit, we have justified confidence in us, and the government can now withdraw the restriction.

**The President.** (In French.) — This is an instance of a government working railways for revenue purposes and objecting to a reduction of rate.

**Mr. William d'Eichthal.** (In French.) — It should be noted that the State's share is almost the whole. Out of the £1,400,000 profits distributed, the State gets £1,260,000.

**Mr. Stuyvesant Fish.** — Mr. President, I would like to ask the gentleman from India one question. I never understood that any government fixed minimum rates. And I want to ask him whether the matter has been referred to the government by the railroad and whether they have refused to reduce those rates, and for what reason?

**Mr. William A. Dring.** — I shall be pleased to answer that question. The reference has been made to the government, and the government has in specific instances been asked to reduce them. The government has hitherto — I know not their reason — declined to reduce the minimum. And now I will give you an instance. The distance from Delhi to Calcutta is 954 miles. We have been charging the minimum rate, practically, for the last fifteen years. We have not been able to reduce our rate from Delhi to Calcutta for fifteen years on account of this minimum. The distance from Delhi to Calcutta, 954 miles, is practically the same as from Chicago to New York. I think I may add that we should be prepared to quote a cheaper rate from Delhi to Calcutta than is quoted by any railway from Chicago to New York, if only the railroad had the power.

**Mr. T. J. Hudson.** — I should like to ask a question as to what is your reason for desiring to reduce that rate. Is it on account of competition, or because of your belief that it will increase your tonnage and make more traffic?

**Mr. William A. Dring.** — We consider that with present quotations we are making such a lot of money, that we might be given the power to offer further attractions.

**Mr. Stuyvesant Fish.** — I should like to ask Mr. Dring another question. Is not the cheapness of carriage in India very much due to the cheapness of labor? Your labor is rather notoriously cheap?

**Mr. William A. Dring.** — Our labor is notoriously cheap. Coal is also very cheap, especially on the East Indian Railway. But labor is cheap, as Mr. Fish has said.

**Mr. Hugh McLachlan,** New South Wales Government Railways. — Mr. President, as a delegate from Australia, and also representing government roads, the same as Mr. Dring, I will say we have rather more elastic conditions and I think more popular clauses than appear to govern the English railways, and we have one clause which I think is more liberal almost than anything prevailing in any railway. Speaking generally as to the scientific principles governing classification, we attempt to manage railways as English railways are managed. So far as a scientific classification is concerned, I think every commercial manager is pretty well convinced that is impossible. But, we have an adaptable classification. We have a number of classes, the same as referred to in the paper read by the foreign gentleman to whom we have just listened. We have several classes and a number of exceptional rates. But, of course, there can be no complete railway classification — every railway will endeavour to get as much as it can. That is practically what binds everyone. Indian government is certainly very exceptional in that respect, because every one wants to give as low rates as he can consistent with fair dividends. But we are governed entirely by the same principle that govern other railways. We get as much as we can consistent with a few general principles as to the nature of the traffic, its value, as to whether it is hazardous, whether it is unduly bulky, and furnishes a fair return. We have comparatively low rates considering we pay high wages. But in regard to the preference clause, that, of course, must be the main difference or the main difficulty with all railroad rates, as to what exception you are going to make. We cannot have a cut and dried classification. We will publish and show the rates over every line we run and every class of goods, and for every particular item of goods, but there must be some elasticity and we have provided for that. We have it in our Act of Parliament under a clause which provides that notwithstanding any rate which is provided in that rate-book, the railroad administration may have the power to quote any rates for any specific class of goods or merchandise under exceptional circumstances, provided, of course, that the rate shall apply to any person using the railway under like circumstances, and under like conditions.

Now, in regard to Mr. Fish's remarks as to American railways, "like circumstances" may cover a multitude of sins; that is to say, a ton of cotton from St. Louis, if they produced cotton, may be carried cheaper from St. Louis to New York than a ton of cotton from Washington to New York, simply because the circumstances are different. But we are practically honest in that respect; we give the administration the power to quote any rate for any class of traffic. The only obligation is that every three months those rates shall be published. If you have power here, according to Mr. Hudson, to alter a rate on five to ten day's notice, the point is, don't you make your arrangements before you publish your rate? Is there any

obligation on you as to the rate not being quoted until after you publish it? I take it that very often your rates may be quoted in advance and their publication is simply a legal obligation. What provision have you to overcome the operation of any rate by secret agreement? That we do not attempt in New South Wales, at any rate. We give general power of administration, we have general principles governing rates, but where special traffic is offered, we have the power of quoting special rates altogether irrespective of what may appear in the classification. The obligation is on us to publish that. Of course, the railways are governed by the administration for the people, they are government lines, and there is no penalty attached to quoting a wrong rate, except this: if mistakes were made, no doubt the administration would, subject to the rule of the people, lose their place. They govern for the people and they are bound, of course, by the desire to render a good return from the property they have in their charge, and so far we have always endeavoured to keep simply within the pale all the time. We can borrow money at  $3\frac{1}{2}$  per cent, and what is attempted is to give an annual return of  $3\frac{1}{2}$  per cent. If we earn 5 per cent, the administration reduce the rate in order to reduce the surplus we have. We have come down to  $3\frac{1}{2}$  per cent, giving  $1\frac{1}{2}$  per cent in shape of reduced charges to the general public. We have elastic conditions, and we have found it answered fairly well.

**Mr. William d'Eichthal.** (In French.) — It would be interesting to know whether the minimum in India is not appreciably above the minimum in other countries.

**Mr. Guerreiro,** Portuguese Ministry for Public Works, Commerce and Industry. (In French.) — The subject is of high interest. It would be well, I too think, to ask whether the minimum rate applies to both standard and to narrow gauge railways, because in that case it would seem more a fiscal tax than interest on capital.

**Mr. W. M. Acworth,** Board of Trade, Great Britain. — May I ask Mr. McLachlan to explain his statement? He said that if there was an excess of over  $3\frac{1}{2}$  per cent, which was the sum necessary to pay interest, the government of New South Wales would reduce the rate. I should like to ask whether this has ever been found necessary in actual practice or whether, in fact, it has not rather been necessary to supplement the rates by taxation almost every year, because the railroad earnings did not pay the  $3\frac{1}{2}$  per cent?

**Mr. Hugh McLachlan.** — We have considerably reduced the rate within recent years. The rates are, practically, very seldom increased, but there have been a great number of decreases. Of course, in some years the railways have not paid. We are a young country, with a very small population, a little over 1 million, and we have 3,500 miles of railway. You may understand that most of our population is on the sea-board, and we are developing the country and the government has had to make up from time to time deficiencies on those railways; but we have made those railways in the new country without any subsidy or without any grant. It is

a question of whether it is not better for the State to do that than to do as they have done in Canada and give away 20 million acres of land. We have kept our land, and as lands increase in value, they have fallen to the people. In Victoria they have made a direct contribution to the railway capital. In view of the increased value of land, they endowed the railways there during a course of years with 15 million dollars in view of the increased value of crown lands.

**Mr. John Pickering, South Australia Government Railways.** — **Mr. President,** Mr. McLachlan has very completely represented the largest state in Australia, but there are one or two points concerning the situation in South Australia that I should like to call attention to lest Mr. McLachlan's remarks might mislead you as to government control of railroads in Australia. You will understand that in each State of Australia the government participates in the control of railway management, and has usually one minister of the crown as commissioner of public works or commissioner of railways, and, of course, he has some influence, and dominates to some extent in railroad management. Then, under the government, there are one railroad commissioner, or two or three railroad commissioners entrusted with the management of the railroads, and usually the acts of Parliament authorizing the construction of railways specify maximum rates for the conveyance of merchandise. I am speaking for my own State only. Those maximum rates are sufficiently high to satisfy all the requirements of the management of railways. The railroad commissioners are allowed to make special rates to secure traffic, but these rates I think, as Mr. McLachlan pointed out, have to be submitted periodically to the government of the country, and with us placed before Parliament every three months. When we are issuing a new classification of rates, that classification, usually issued in the form of a by-law, has to be submitted to the government with us and placed before Parliament and gazetted.

As to the question of making up this  $3\frac{1}{2}$  per cent on capital, with us I think it differs a little from the method adopted in New South Wales. I hold in my hand a summary of Australasian statistics — that is, including Australia and New Zealand. I do not intend to inflict this upon you this morning, this is not the time for that, but I see from these statistics that the net revenue on the Australasian railways for the year last published was 3·2 per cent, or  $3\frac{1}{5}$  per cent on the capital cost. It may be said that this is not a fair year to take, because Australia has been suffering from a disastrous drought, in fact has been suffering from that for five or six or seven years, in which time we have lost a considerable amount of our live stock and the condition generally has been very much depressed. In the year I mention  $3\frac{2}{10}$  per cent was the rate, and the year we are now in, ending the 30<sup>th</sup> of June, will show a better result. In South Australia, when we had this drought, we raised our rates all through, our passenger fares and our rates on freight, so as to pay our way, and earn something like  $3\frac{1}{2}$  per cent on the capital cost. It is not usual to do it, it is only done in emergencies. You understand very often in America rates are raised on

one line and the result is to throw traffic to another line in such a case; but in Australia there is a monopoly, there is no railway competition in the State, the government can raise the rates or lower the rates; thus in brief charging the consumers on the railways — who are practically the proprietors — the cost price for carrying passengers and merchandise.

I think that represents perhaps the only difference from what Mr. McLachlan has said, and you will understand perhaps a little more clearly the method adopted in Australia as a whole.

**Mr. Stuyvesant Fish.** — Mr. Pickering, did we understand you correctly that the railways in your country are government railways pure and simple?

**Mr. John Pickering.** — Yes, that is so practically.

**Mr. Stuyvesant Fish.** — I would say one thing in this connection. Mr. Pickering spoke of the raise of the rates on account of public distress, in the case he mentions, the distress being a severe drought. That is exactly contrary to what we are obliged to do in such a case. If there comes a time of depression in America, such as there was from 1893 to 1897, we have to reduce our rates to keep the wheels of commerce moving. We have done that over and over again in every line.

**Mr. John Pickering.** — It might be misleading if I were not to add that there have been times (the time of the disastrous drought for instance) where we have had to meet the necessities of the settlers and reduce our rate, carrying starving live stock long distances at a merely nominal rate in order that the lives of the cattle may be spared as much as possible. And in other directions in times of distress we have lowered the rate very considerably; but I was only speaking of raising the rates when things were looking better and when the people generally could afford to pay higher rates.

**Mr. James Douglas.** — It is almost unnecessary to add anything perhaps, but I would say that in the arid region in the west the railroads generally put in what they call emergency cattle rates, meeting exactly the same conditions you speak of.

**Mr. John Pickering.** — We have carried fodder for  $\frac{1}{2}$  dollar a ton for long distances.

**Mr. James Douglas.** — That is exactly the case that we have to meet and that is an emergency rate.

**Mr. Stuyvesant Fish.** — The case Mr. Douglas cites and the case Mr. Pickering cited are a little different from what I had in mind. What I want to speak of is a period not due to drought, not due to local conditions, but a general depression in business which comes over the whole country now and then, every ten or a dozen years. In those cases, the American railways have been forced by circumstances, by competition among themselves, by the necessity in a new country of keeping, as I say, the wheels

of commerce moving, keeping business going, to reduce their tariffs generally, not only upon cattle or fodder for cattle, but upon such articles as pig iron, upon general articles of commerce, making a general reduction in the whole tariff, so that the railway shall take a less profit at the time when the merchant is making a poor profit or no profit and the manufacturer making a poor profit or no profit. We come forward and have come forward over and over again to share in their losses. Our trouble to-day is that with the great prosperity that is now general throughout the United States — for, as you know, we are in a period of remarkable prosperity at present — we have the utmost difficulty in increasing our rates, putting them back to where they were before they were reduced seven or eight years ago, and which it is necessary to do on account of our increased expenses and the increased cost of operation owing to increased prices of material and labor.

I think the difficulty of our position is due to the great number of corporations in this country and to the control by State governments to which Mr. Hudson has alluded, the State governments regulating us in detail, and to the United States government regulating us wholesale.

**Mr. Piéron, French Northern Railway.** (In French.) — I apologise for rising just when the time for lunch has arrived for most of us, but, if you will permit me, I should like to allude briefly to some lines that have not been mentioned so far, namely some lines of local interest, mostly in France. Of these the Northern Company, which I have the honour of representing, owns a good many, amounting to some 1,000 kilometres (620 miles) in length. These lines were built to serve districts with comparatively little traffic to offer, but still they serve quite respectable interests and act as feeders to the main lines.

It is obviously essential that these local lines should have special provisions and so it is necessary to make the rates as elastic as possible so as to respect the interests of the small companies at the same time as those of the great companies. This is the only remark I have to make and it bears out the notion that in the matter of rates everyone must look after his own interests, after the interests of trade of course, of industry and of the companies themselves.

**The President.** (In French.) — As the lunch hour is at hand, we might now close the discussion.

From the discussion that has taken place, I gather that everyone agrees that rates ought to be, above all, commercial rates, in the interests not only of the carrier but also of the public and so fixed as to allow railways to render the community the utmost service possible by meeting the needs of commerce however variable they may be. We might, if you like, summarize this view in a conclusion which I am going to submit to you in French and in English :

“ Tariffs should be based on commercial principles taking into account the special conditions which bear upon the commercial value of the services rendered.

“ With the reservation that rates shall be charged without arbitrary discrimination to all shippers alike under like conditions, the making of rates should, as far as possible, have all the elasticity necessary to permit the development of the traffic and to produce the most beneficial results to the public and to the railroads themselves. ”

- These conclusions were adopted.
- The meeting then adjourned.

## DISCUSSION AT THE GENERAL MEETING

---

Meeting held on May 11, 1905 (afternoon).

---

MR. STUYVESANT FISH, PRESIDENT, IN THE CHAIR.

GENERAL SECRETARY : MR. L. WEISSENBRUCH.

ASSOCIATE GENERAL SECRETARY : MR. W. F. ALLEN.

The President read the

### Report of the 4<sup>th</sup> section.

(See the *Daily Journal of the session*, No. 5, p. 87, and No. 7, p. 129.)

“ The PRESIDENT called attention to the necessity of confining the discussion to general principles. As to the description of systems of freight rates in different countries, the reports furnished interesting information, the examination of which in detail it would be difficult to consider during the discussion.

“ Mr. Lewis Wood (*Railway Clearing House, Great Britain*), in place of Mr. Harry Smart, reporter for England, stated that all the railroad companies of the United Kingdom of Great Britain and Ireland were created by Act of Parliament which fixed the maximum freight charges which the companies might make for transportation. The tariffs which companies were previously authorized to establish, were not uniform because of the different acts under which they were organized. As classifications of merchandise were relatively few in number, many incongruities resulted. In 1881, the House of Commons appointed a special commission to make an investigation regarding the traffic of railroads and canals. This inquiry resulted at first in the Railways and Canals Traffic Act of 1888, and then as a result of new petitions and suggestions from the companies, in the Laws of the Railway (Rates and Charges) Order, Confirmation Acts of 1891 and 1892. These acts established, firstly, a general classification of the various classes of freight; secondly, the maximum limit of supplementary charges; thirdly, the maximum rate of transportation per ton-mile for each class.

“ In addition to the official classification, the companies have deemed it useful to publish a working classification corresponding to the charges actually made. Also with a view of encouraging the development of business, the companies have made special rates lower than the regular tariff, based on the earnings per car-mile and terminal expenses.

“ In some cases, tariffs have been especially reduced for large movements of freight between given points during a certain period.

“ In making any special rates, the companies are not permitted to discriminate between shippers. No distinction is made in the tariffs as regards the time within which the goods are to be delivered, but for many articles, lower rates are made for special conditions which relieve the operating companies from responsibility as to losses, damages, mis-delivery, delay or detention, except in the case of negligence on the part of the railroad.

“ The tariffs are submitted to the Board of Trade, which settles by arbitration any disagreement between the companies and the public, but it has no right either to fix or to modify tariffs.

“ Mr. MANGE (*Orleans Railway*) then presented an abstract of the report by Mr. VAN OVERBEEK DE MEYER (*Netherland State Railways*) for all countries except America, England, Spain, Portugal, France, Italy and Belgium.

“ The report of Mr. Van Overbeek de Meyer contains very interesting information on the freight rates of all the countries to which it refers, especially those of Germany, which not only take into account the value of each article, but also the commercial value of the service rendered, as well as the various requirements of industries due to their location and the importance of the traffic which they supply. On these principles, the German system groups the articles in tariffs for broken lots and in tariffs for carloads. There exist besides special tariffs for exceptional cases, as, for instance, to compete with waterways or foreign railways, to help certain national industries, or to encourage exports or imports, etc.

“ As a whole, for all countries considered, the fundamental system is a mixed system, based in part on the value and in part on the weight and bulk of the merchandise. The determining consideration is always that of the commercial value of the service rendered, taking into account the actual value of the material as well as any special considerations, such as competition with waterways, etc.

“ As to the relations of the management of the railroads with their governments, tariffs are in general first submitted for approval except some tariffs which apply to certain classes of merchandise under special conditions.

“ The reporter considered whether it would be possible to create, for different countries, a uniform system of freight charges, so as to have a single organization like the Convention of Berne. While in principle disposed to reply affirmatively to this question, the reporter concludes that there is too much difference between the conditions and the special needs of the various systems in different countries for it

to be practicable to establish uniform regulations which would apply to all countries; still more so, since no railroad could change the present system without affecting the national interests which it serves.

“ The third report presented to the section, was that of Mr. MANGE for France, Belgium, Italy, Spain and Portugal.

“ Mr. Mange stated that the rate should be between two limits : Firstly, the commercial value of the service rendered by the carrier, which constitutes the highest limit which the public can be asked to pay ; secondly, the actual cost of transportation. The latter, that is, the cost of transportation, may be considered from two different standpoints, either as an average cost, that is, the ratio of the total expenses of operation (and interest charges on the capital) to the total traffic, or, as the actual cost of transporting any particular article. The latter is generally lower than the average cost, because it only includes the operating expenses which this special movement requires, the interest charges on the capital and certain fixed expenses of operation having already been covered by other traffic. The tariffs may establish rates between these two limits. When the rates are decreased, they increase the traffic and at first the receipts too; but the receipts attain a maximum and then decrease by degrees to zero when the tariff disappears. On the contrary, the expense increases more or less slowly, but constantly with the tonnage. It follows, therefore, that a rate can be found at which the profit — the difference between the receipts and the expenses — is greatest, and this is the rate which the operator, acting commercially, should try to realize. It is generally well below the limit above which the tariff ceases to be prohibitive, and because of this, the expression “ what the traffic can bear ” has been misinterpreted. The latter sentence does not mean a price immediately below that at which no transportation could take place. but such a price as would develop the traffic to a degree allowing the greatest profit to the operator.

“ In practice, the determination of the tariff allowing the maximum benefit is impossible because of the complex character of the problem. The commercial value of the service rendered it constantly changing, as the centres of production and consumption react upon each other. The law of increasing the traffic in proportion to lowering the tariff, is not known in advance. Finally, the cost of transportation itself cannot be determined except approximately. We are, therefore, compelled to adhere to less theoretical considerations, and to base the freight charges on more simple data, but all these considerations show that the establishment of a tariff system is not a question which can be solved by formulæ, but that it forms a problem requiring the greatest commercial ability and careful study in each case.

“ Proceeding next to the examination of the various principles on which the systems of freight charges are based, the reporter stated that on private systems the statutory powers contain, as a rule, maximum tariff charges, which in the interest of simplicity were based on a general classification of merchandise according of value and length of haul. Below these maxima, the operating administration has a

right to make such reductions as it considers desirable, on the condition that the maximum fixed by the statute is respected.

“ The necessity for acquiring competitive traffic from pre-existing means of transportation, such as vehicle traffic and shipping, has led them in general to make tariffs in the same way as those in use on competing lines, that is, by means of rates based on the commercial value of the service rendered.

“ The State of Belgium, on the contrary, had from the beginning a tariff system based more specially on the cost price, which gave a uniform price per car per kilometre, without regard to the value of the merchandise and the direction in which it was carried. This uniformity can also be explained by the fact that the system of the Belgian roads was competing on all its lines with water transportation, from which it follows that it required the same uniform reduction in charges which had to approximate the cost of transportation. Similarly, the majority of the systems in all other countries have been compelled by various considerations to reduce their charges to approximately the cost price and to reduce this cost price by taking advantage of special conditions, such as : 1° the tonnage of the material shipped, making allowance for transportation by car load lots; 2° the length of haul establishing differential tariffs; 3° making the public do the accessory operations (loading, unloading, clerical charges), building private sidings, reducing the delays in unloading, use of special cars, etc.; 4° decreasing the responsibility of the carrier; 5° in some special cases the establishment of improved physical conditions of the line, especially reduction in grades.

“ But if it is correct to take into account these considerations in fixing the freight charges, they cannot serve as an exclusive basis for a tariff system. The shippers are inclined to pay for transportation what it is worth to them, and not what it costs to the carrier. Moreover, the cost price of each shipment cannot be determined, so that only an average cost price could be used, which would lead to an arbitrary basis having no real relation to the service rendered in each case. Finally, the system would lead either to very high charges for merchandise of small value, or to such low charges as would result in losses to the carrier.

“ In fact, the railroads which, like those of Belgium and Germany, were in favour of a very simple tariff system, chiefly based on the cost price, have been led to depart from it gradually through modifying their tariffs according to the commercial value of the service rendered.

“ The private systems, on the contrary, which began their tariff systems exclusively on constant units, have replaced them progressively in most cases by the ton-mile scale; while recognizing that this tendency is favourable to clearness and simplicity in tariff systems, it should not be forgotten that to develop the traffic, which is the final aim to be attained, the ton mile scale does not always have a sufficient elasticity and we are often compelled to fix rates in special cases where they are necessary, either to create a traffic which would otherwise not exist, or to enable the railroad to acquire its share of a business which would otherwise be

handled by other lines. In this respect, Mr. Mange quoted as an interesting example a fact pointed out by Mr. J. J. Hill, president of the Great Northern Railway, in the statement which he recently made before the American Senate on the question of tariff legislation. Mr. J. J. Hill stated that he has made for the carrying of timber coming from the Pacific coast a reduction in rates which involved a loss at the beginning, but owing to the development of the traffic caused by this reduction, the cost of transportation itself has sufficiently decreased so that the rate now yields a profit.

“ It is certainly important that the public authorities should see that the railroads do not become an instrument of favour or oppression, do not create what is known in England and America as “ undue preferences, ” but with this limitation, it is to the general interest to leave to the management a certain latitude in establishing freight charges so that they should be able to develop traffic and attain the most beneficial results.

“ On the invitation of the PRESIDENT, Mr. T. J. HUDSON (*Illinois Central Railroad*) submitted to the section interesting information on the rules which control the establishment of freight charges on the railroads of the United States.

“ Mr. T. J. Hudson concluded from the reading of Mr. Harry Smart’s report that the principles applicable in England are the same as those which control the establishment of freight charges in the United States, but what especially characterizes the freight charges of the United States, is very great flexibility due to the commercial and industrial conditions.

“ There are two sorts of tariffs : 1° the general tariff, which is relatively fixed ; 2° the tariffs for special shipments (such as commodity tariffs), which are intended for great volumes of traffic, especially for the need of great industries, which explains why they are so changeable. Coal, metals, timber, etc., take an exceptionally low rate.

“ Moreover, questions of competition, as well as of export, enter sufficiently to warrant exceptionally low charges.

“ Freight tariffs are regulated by the Interstate Commerce Commission, which requires their publication and which also intervenes in disagreements between the railroads and the public, leaving, of course, appeal to the courts.

“ Mr. Stuyvesant FISH (*Illinois Central Railroad*) confirmed the information furnished by Mr. T. J. Hudson and added that for the last eighteen years, during which the Interstate Commerce Commission has existed, there have been very few decisions against the companies.

“ Mr. T. H. RENDELL (*Great Western Railway of England*) asked to be informed as to the mode of procedure in the United States, in cases such as are frequently met with in England where, with a great extent of coast, in order to meet the competition with water traffic, the railroads often find it to their interest to fix the tariff so

that it will be lower between two points, A and C, than the tariff between A and B, the latter being situated between A and C. The obligation which the roads have in England not to allow any preference, is an obstacle to a reduction of the tariff in such cases, while at the same time, the railroads might have an interest to do so in the case referred to, but are afraid of the intervention of the authorities controlling the tariffs.

“ Answering this question, Mr. Stuyvesant Fish replied that the American method is more liberal. Here inequalities of treatment are also prohibited, and it is, therefore, not possible to make higher charges from A to B than from A to C by the route passing through B under substantially similar conditions, but if the conditions are different there is nothing in principle which would prevent the rate between A and C being lower.

“ Mr. G. LE GRAIN (*French State Railways*), returning to the report of Mr. Mange, expressed his fear that the feature of service to the public which every railroad enterprise involves, has not sufficiently been brought out. Service to the public means equal treatment; that is a feature which nobody questions and which is a factor in establishing tariffs as well as the commercial value of the services rendered which had been the predominating idea in the reports presented here.

“ Mr. William A. DRING (*East Indian Railway*) drew an interesting picture of railway management in India. The railways are, in the main, the property of the government, and operated either directly by the government or by companies. In either case, the government, with a view to securing returns from its investments, has established minimum tariffs as well as maximum tariffs. Since these minimum tariffs were put into effect, some fifteen years ago, working conditions have been greatly changed, both as regards increased volume of traffic and reduction of operating expenses. Labor and coal are very cheap; the gradients of lines are also very favourable; for all these reasons, it has been possible to lower tariffs gradually until in certain cases, the minimum rates have been reached; and the result to-day is that these minimum rates are becoming a disadvantage in certain cases. Consequently, the operating companies have had to consider the question of lowering these minimum rates or preferably of withdrawing them altogether.

“ Replying to inquiries on this point, Mr. W. A. Dring confirmed the fact that applications for the lowering of the minimum rates have been made to the government, which has refused to allow them. In some cases, earnings from capital invested have risen to 7 or 8 per cent.

“ Mr. James PICKERING (*South Australia Government Railways*), and Mr. Hugh McLACHLAN (*New South Wales Government Railways*) made an interesting report on tariff making in Australia, which on the main lines is very similar to that in other countries. There is the regular tariff rate and special tariffs, which are adapted to

circumstances, with the condition of no favoritism and the requirement of formal publication.

“ Railways in Australia are built like those in India, and the government, which furnishes the capital, requires a revenue of  $3\frac{1}{2}$  per cent, in addition to which any increase in earnings is applied to the reduction of tariff rates. On the other hand, if this revenue is not earned, as was the case in 1904, owing to an exceptionally heavy drought, tariffs are raised.

“ Referring to this statement, Mr. Stuyvesant Fish remarked that an increase of tariff rates ought not to be considered a profitable transaction for railways, when the economic situation of the country is in a state of depression. It would appear, on the contrary, that it would be to the interest of the railway to assist in the revival of business by lowering its rates. The difficult part is after hard times are over, to restore the rates in force before the period of depression.

“ Mr. PIÉRON (*French Northern Railway*) expressed the opinion that lines of only local importance should not be required to observe such strict rules as lines of larger interest in the matter of tariff making.

“ The discussion was closed and the following resolution was unanimously adopted. ”

**The President.** — The following are the

#### CONCLUSIONS.

“ Tariffs should be based on commercial principles taking into account the special conditions which bear upon the commercial value of the services rendered.

“ With the reservation that rates shall be charged without arbitrary discrimination to all shippers alike under like conditions, the making of rates should, as far as possible, have all the elasticity necessary to permit the development of the traffic and to produce the most beneficial results to the public and to the railroads themselves. ”

— These conclusions were adopted by the general meeting.

---

## APPENDIX

### Note on the freight rates on the Indian railways,

By WILLIAM A. DRING,

GENERAL TRAFFIC MANAGER, EAST INDIAN RAILWAY.

**1. Indian railways the property of the State.** — Treating generally of the railways in India, they are the property of the State, and are worked either directly by the State, or by companies constituted for that purpose, which administer the lines under contract with the secretary of State for India, who retains large powers of control. These companies receive remuneration for their services, by means of a division of the net profits after payment of the working expenses, and the interest charges on the capital expenditure, the government reserving to itself the lion's share. Thus in the case of the most prosperous railway worked by a company, out of net or surplus profits for a year amounting to £1,400,000, the State received £1,260,000 and the company the balance of £140,000.

**2. Chief features of Indian lines.** — The following particulars for the railways in India during the year 1903 are given in the form adopted by Mr. Harry Smart, secretary of the Railway Clearing House, in his paper on slow freight rates in the United Kingdom. The year taken is 1903, the figures for 1904 not being complete :

a) Length of railways worked . . . . .	26,955 miles.
b) Receipts per mile . . . . .	£891.
c) Cost per mile of maintenance of way, works, etc. . . . .	£100.
d) Expenditure of all kinds per mile. . . . .	£424.
e) Proportion per cent of expenses to receipts . . . . .	47·5.

The receipts from coaching traffic are about one-third of the whole, and from merchandise and mineral traffic, taken together, about two-thirds. The total weight carried of merchandise and coal, including stores for consumption on the several railways, was 47,684,000 tons, and the average distance per consignment carried, or the average lead of the traffic as a whole, was 160 miles.

It should be stated that in the year 1904 there was a great advance in the prosperity of Indian railways, and it is estimated that when the detailed figures of working are published, they will

shew in gross receipts an advance over 1903 of not less than 10 per cent with a reduction in the proportion per cent of expenses to receipts.

This prosperity has enabled the State to develop its programme for the enlargement of the railway system in India, and the improved equipment of existing lines.

The greatest average construction of railways in India per annum was during the first Vice-royalty of His Excellency Lord Curzon from 1899 to 1903, when the average actual mileage opened per annum was as nearly as possible 1,000 miles. During the last year of the series it was arranged to construct over 1,250 miles.

**3. Control by government over rates.** — The initial control exercised by the government of India over rates for the carriage of merchandise and coal, is by means of a scale laying down the maximum and the minimum rates which may be charged for the various commodities. The scale may be summarized as follows, it being premised that 1 pie equals  $\frac{1}{12}$  of a penny, and a maund  $\frac{1}{28}$  of a ton of 2,240 lb.

	<i>Maximum.</i>	<i>Minimum.</i>
	Pie per maund (pence per English ton) per mile.	Pie per maund (pence per English ton) per mile.
Coal, wheat, other grain, oil-seeds, jute, salt and other articles of low value, iron . . . . .	$\frac{1}{3}$ (0·777)	$\frac{1}{10}$ (0·233)
Ordinary commodities . . . . .	Between $\frac{1}{3}$ and 1 (between 0·777 and 2·333)	$\frac{1}{6}$ (0·388)

There are powers allowing special treatment of articles of exceptional bulk in regard to weight, such as loose cotton, heavy articles such as boilers, and articles of exceptional value, such as specie or bullion.

The highest charge allowed is therefore  $\frac{28}{12}$ , or 2  $\frac{1}{3}$  pence per ton-mile of 2,240 lb., and the lowest  $\frac{1}{10}$  of this amount, or 0·233 of a penny, somewhat less than 1 farthing per ton-mile. The average actual charge made in 1903 on the total merchandise and coal traffic of all Indian railways, taken together, was 0·47 penny per mile per ton of 2,240 lb. or 0·41 penny per mile per ton of 2,000 lb.

**4. Standard classification.** — Confined within the maximum and minimum charges, there are separate standard classifications for ordinary merchandise and for coal. With regard to the great majority of ordinary items of merchandise, there is uniformity of classification on the different railway systems, but for raw agricultural products, salt, iron, gunny, kerosene oil, etc., forming the bulk of the ordinary merchandise traffic, each principal system has its own scale.

**ORDINARY MERCHANDISE.** — The standard classification for ordinary merchandise has remained unaltered for a number of years, the requirements arising from time to time for reduction in charges having been met by the quotation of special, or station to station, rates, always within the limits laid down by the government of India. The scale of charge to the consignor is in this way being constantly reduced.

For ordinary commodities there is no differential treatment or lowering of rates as the mileage is increased. With agricultural produce and other articles of low value, this treatment is adopted. The following standard classification in force on the East Indian Railway, which carries a heavier traffic than any other line in India, may be taken as to “special” class (prin-

cipally agricultural produce) goods as applying approximately throughout the trunk lines of India, and as to ordinary commodities, as actually so applying.

**SPECIAL CLASS :**

For first 100 miles . . . . .	0·3333 pie per maund (0·777 <i>d.</i> per English ton) per mile.
For extra distances above 100 up to 450 . . . . .	0·17 — (0·397 <i>d.</i> — ) —
— — — 450 miles . . . . .	0·12 — (0·280 <i>d.</i> — ) —

**ORDINARY COMMODITIES :**

	<i>Rate :</i>
1 <sup>st</sup> class . . . . .	$\frac{1}{3}$ pie per maund (0·777 <i>d.</i> per English ton) per mile.
2 <sup>nd</sup> — . . . . .	$\frac{1}{2}$ — (1·166 <i>d.</i> — ) —
3 <sup>rd</sup> — . . . . .	$\frac{2}{3}$ — (1·554 <i>d.</i> — ) —
4 <sup>th</sup> — . . . . .	$\frac{5}{6}$ — (1·944 <i>d.</i> — ) —
5 <sup>th</sup> — . . . . .	1 — (2·333 <i>d.</i> — ) —

The commodities included in higher classes than the second which pays as nearly as possible 1 penny per ton-mile of 2,000 lb. form a very small proportion of the whole traffic.

The rates given in the ordinary commodity schedule are the highest allowed by the government control, for each class. The reductions below the respective scales, within the government minimum of  $\frac{1}{6}$  pie per maund (0·388*d.* per English ton) per mile, are generally speaking by means of station to station quotations.

**5. Terminals.** — Terminals may be added varying between, say, 7 pence and half a crown per ton, the average probably being between 1 shilling and 1 shilling 6 pence. These terminals are, however, frequently remitted, especially in the case of traffic carried over considerable distances. For the terminal charge made, loading and unloading are performed by the railway; but there is no cartage or other delivery off the premises, except in a few isolated cases, consignors and consignees being left to perform these services themselves.

**6. Alterations in rates.** — In addition to the control exercised by government by means of maximum and minimum rates, the power is retained of ordering specific quotations if considered to be required — though such power has not in the experience of the writer been ever used; — and alterations in rates are scrutinized by government officers at the head quarters of the several lines. Every change in charge must be included in a statement submitted monthly for scrutiny; and permission must be obtained from the local government controlling officer before transfer of an item from one classification to another. Every authorized charge is included in a printed rate book, and invoices are checked by the accounts department. An invoiced rate not given in the rate book is objected to, and for each alteration in the rate book or tariff authority must be shewn. At the present time, there is indication of a relaxation of the control exercised in the matter of rates; but it seems probable that the working companies when proposing changes of great importance will, even though they may be acting within their powers as governed by the standard of maximum and minimum rates, ascertain, before introducing the changes, the views of government as the predominant partner in the undertakings placed in companies' charge.

**7. Liability.** — Railways in India as to liability are not common carriers, but bailees for hire. They are required to take the same amount of care of goods entrusted to them for carriage as a man of ordinary prudence would take of his own property. They are further allowed to relieve

themselves of this liability by the quotation of reduced rates at owner's risk, and if these reduced rates are accepted by the consignor, the railway is freed from all responsibility from whatever cause arising, even though that cause may be the proved neglect or dishonesty of the servants of the railway. There has been some comment on the extent to which freedom from liability is carried. Certain articles of special value, such as those of which gold or silver forms part, and Cashmere shawls, are "excepted," that is, the railway incurs no liability for their loss or damage.

**8. Reduced rates for wagon loads.** — In India, special attention is paid to the securing of good wagon loads. The carrying capacity of wagons is higher than on English lines, the standard gross load of four-wheeled wagons constructed during the last ten years being for the broad gauge (5 ft. 6 in.) 24 tons, of which the net load is 16 or 17 tons. Certain railways are now increasing the load of four-wheeled wagons to 28 tons, of which the net load is 20 tons. In order to make full use of the individual wagon capacity, the practice is growing of offering reduced rates for consignments of weights suited to the wagon capacity. The Calcutta export trade in wheat and seeds was till a year ago carried in multiples of 25 tons, each consignment taking two wagons; but the offer of a reduced rate by about 6 per cent for 30 ton lots has been quite successful, and at the present time, the two wagons which formerly carried 25 tons are taking 30 tons, and the reduction of 6 per cent in charge has brought an increase of 20 per cent on the wagon load. For 1903, the average load of a loaded goods vehicle, on principal railways varied between 7 and 9 tons, excluding mineral traffic of which the average load is considerably greater. Taking into consideration empty running, the average load varied between 5 and 6  $\frac{1}{2}$  tons.

With the same object of inducing full use of the wagon capacity, charges are quoted per wagon load of a particular commodity, the consignor gaining an advantage as compared with maund rates if he puts in a good load. This principle has not so far been applied to wagons with mixed loads of different commodities, where a middle-man steps in and shares with the consignor the advantage of reduced freight charges.

**9. Group rates.** — Group rates for the principal commodities are coming into favour in India. Although there are exceptions of great importance, there is general acceptance of the "differential rates," under which on the same length of line, the charge for the lesser distance shall not exceed that for the greater.

**10. Coal.** — The charges for the carriage of coal have received special attention, and during the last fifteen years there have been two reductions in the scale of rates, of great importance. Before the first reduction, British coal was imported into Calcutta in considerable quantities, although coal of good quality was being raised at collieries, having direct railway communication situated within 130 miles of Calcutta, while all other ports were supplied exclusively with British or foreign coal. The export of coal from Calcutta was unknown. At the present time, practically all the coal consumed in India is mined in India, and large exports are made to Colombo, Singapore, and other external ports. Excluding bunker coal, there were shipped from Calcutta in 1904 over 2 million tons of coal.

The principal collieries are situated on the line of rail at an average distance of about 150 miles from Calcutta. These collieries in addition to sending to the port, consign coal over long distances to the interior, at present principally for railway consumption. Probably more than  $\frac{1}{4}$  million of tons are sent over distances exceeding 1,000 miles.

The collieries so far opened out in India, other than those near to Calcutta, are not of very great importance, the raising for 1903 having been about 1 million tons only.

The first of the two reductions referred to in the opening portion of this paragraph having proved most successful in establishing an altogether new trade, the second reduction to the present scale, was decided upon with the view of affording an impetus to the export trade, and also to assist coal in replacing wood and other descriptions of fuel at long distances in the interior. The scale is here given :

						Per maund (per English ton) per mile.
For all distances up to 75 miles inclusive . . . . .						0·14 pie (0·327 <i>d.</i> ).
Plus for any distance in excess of 75 miles, and up to 200 miles inclusive . . .						0·12 — (0·280 <i>d.</i> ).
—	—	200	—	450	—	0·1 — (0·233 <i>d.</i> ).
—	—	450	—	1,000	—	0·09 — (0·210 <i>d.</i> ).

The total charge being subject to the minimum fixed by government of  $\frac{1}{10}$  pie per maund (0·233*d.* per English ton) per mile, or something under one farthing per ton-mile of 2,240 lb.

The scale shews that even during the first miles of its carriage, coal is charged at less than  $\frac{1}{3}$  of a penny per ton-mile of 2,240 lb., while for every mile over 450, the charge is reduced as low as  $\frac{1}{5}$  of a penny per ton-mile.

In order to assist the export of coal, a rebate of 20 per cent is given off tariff rates. The value of coal as exported from Calcutta may be taken at 9*s.*6*d.* per ton of 2,240 lb., which includes cost of coal, carriage over 150 miles by rail, and shipment charges, *i. e.*, *f. o. b.*

Coal is charged at owner's risk, and is loaded and unloaded by sender and consignee. The charges which have been given apply generally throughout the principal colliery districts.

**11.** — So far as concerns coal, Indian railways have a clear and concise tariff, without complications. There are no special station to station rates, and everything is according to the one scale, except where, under agreement, the longer route between the same points has equalized with the shorter, the charges in these cases being calculated by the scale on the shorter route. This simplicity is rendered possible by the circumstance that there is only one principal source of supply, and therefore no competition between different source of supply competing for the trade of the markets of consumption.

**12. Special quotations.** — For raw agricultural products there are probably not more special quotations than the importance of the traffic warrants. Here there are both competing sources of supply, and competing marts of distribution.

For ordinary and unimportant articles, however, a mass of station to station rates, and exceptional conditions, has sprung up for the reason that there has been no general revision of classification, but individual treatment of each of some thousands of commodities. On pages 37 and 38 of the paper by Mr. Mange, assistant traffic manager, Orleans Railway (<sup>1</sup>), it is shewn that a similar growth of special quotations on the Paris-Lyons-Mediterranean Railway has been met by reductions in scale, and abolition of the bulk of the station to station rates. The reduction of the scale necessarily could not be to the level of the lowest special quotation, and we are told that while those who profited by the general reduction kept silent, the sufferers by the increases

(<sup>1</sup>) Vide *Bulletin of the Railway Congress*, No. 1, January, 1905, p. 235 and 236.

protested energetically, so that although the reform was a considerable step in advance, it appeared to give rise to nothing but discontent.

There was the difficulty in making the alterations in the tariff of the French line that commodities of the first importance came under revision; but, as it has been endeavoured to show in this note, on Indian lines the scale for the charge of coal is simple, and agricultural products have not undue complications, though there is probably a number of station to station rates which, at one time necessary, have served their purpose, and could be withdrawn. Of the five ordinary classes, it is probable that a readjustment in scale could be arrived at for the three higher classes, which without having any seriously detrimental effect on revenue, would enable the great bulk of the station to station rates to be withdrawn without causing discontent to consignors. The same remarks apply in a less degree to the two lower classes of ordinary goods. Here larger interests are concerned, both for the consignor and for the railway. Profiting by the experience of the French line, important station to station rates would be preserved; but with a small reduction in scale a large number of special quotations would disappear.

The subject of simplification of goods tariff is now having the attention of the Indian Railway Conference Association.

**13. Possible developments.** — The question of slow freight rates for Indian Railways, is at present in an interesting position. While, as shown in paragraph 3 of this note, the powers given to the managements of the various lines by the government which owns the lines permit a maximum charge on high class goods of  $2\frac{1}{3}$  pence per ton-mile, and on coal and low class goods a maximum of one-third of this amount, or 0.77 penny per ton-mile; and forbid a lower charge than 0.38 penny for high class goods, and than 0.23 penny for coal and low class goods, the *average* charge in 1903 on all Indian railways taken together, was for all merchandise, including coal, under 0.5 penny per-ton mile, and for coal taken by itself 0.26 penny per ton-mile. The average charge made is thus out of all proportion nearer to the minimum than to the maximum allowed, the result being brought about by the low rates levied on coal carried for export or over long distances to the interior, and on grain and seeds carried to the ports of Calcutta, Bombay and Kurrachee. Many of these rates are actually down to the minimum allowed of 0.23 penny per ton-mile.

**14. Railways now profitable to the State.** — Until the commencement of the present decade, the government of India as a proprietor and guarantor of railways was losing large sums of money annually on the working of the railways as a whole, but for four years in succession there has been a surplus, and there has been such steady progress that it may be hoped that for the future the position will constantly be of income greater than expenditure. It is, however, by no means the case that all railways earn sufficient to cover their working expenses and the interest on capital outlay. The statistics, indeed, shew that of a total mileage of say 27,000, only about 10,000 miles are being worked at any profit, and only about 5,000 miles at any considerable profit. Carrying the examination a step further, it is seen that the system of about 2,250 miles from which the largest share out of all proportion of the profits comes, is that which charges the lowest rates, this system being specially favoured in the matter of gradients, coal and a steady traffic, so that the cost per ton-mile carried is much lower than on other Indian lines.

**15. Cost per ton-mile.** — In India there are accurate statistics of ton-miles, and a rough and ready method has been adopted of apportioning the cost of working between coaching, and goods

traffic. This method is open to just criticism, but for the purpose of comparison between different lines may be accepted without fear of great error, the proportion of goods and coaching traffic to the whole on important railways not being dissimilar.

There are three principal ports to be served, Calcutta, Bombay and Kurrachee. Working on an average for five years, and assuming the cost of carriage to Calcutta as 1, the cost to Bombay is 1·81 and to Kurrachee 1·80.

**16. Present minimum a restraint.** — The present minimum charge of 0·23 penny per ton-mile is acting as a restraint on the operations of the managements to which government has entrusted the working of its railways, and it seems probable that in the early future government may consider whether the minimum can be reduced. There will then be the problem whether, as hitherto, there shall be one minimum for all alike, or whether the cheap working line shall be allowed to charge a lower rate than the system where the prevailing conditions do not permit of the same economy. In other words, whether the cost of working shall be taken into consideration in fixing the minimum rate which may be quoted by the different systems. It is too much to expect that there shall be a different minimum for each railway, small and large, but it is submitted that different minimum rates based on cost of working could be laid down for the larger systems, and a general minimum for the smaller, and that such a procedure would be both fair to the consignor whose goods are to be carried, and in the interests of government as owning the railways.

---

## MISCELLANEOUS INFORMATION

---

[ 54 ]

### 1. — The radium controversy.

(*Engineering.*)

The controversy on the real nature of radium, which was initiated by Lord Kelvin in his letter to the *Times* on Thursday, the 9<sup>th</sup> of August, 1906, appears to be an instance of historic plagiarism, and has many precedents in the record of scientific progress. Thus Laplace was unable to accept the undulatory theory of light; Lavoisier's ideas found their strongest opponents in some of the most renowned chemists of his time, and Darwin's work on evolution owed its success to the then rising generation of naturalists, rather than to any assistance it received from those whose reputation was already established. In principle, physical and chemical theories should be held with a light grasp. As professor J. J. Thomson has said in a recent address, a physical theory is "a policy rather than a creed," and the physicist should always be ready to abandon or modify his views of the intimate nature of things as the necessity arises. Nevertheless, this is undoubtedly a counsel of perfection, and, as stated, there have been many instances in the past where men of even the highest scientific capacity, and whose record has earned them an international renown, have proved unable to effect very necessary modifications in the theoretical conceptions which have guided their work. Probably much of their past success has been largely due to the clearness and vividness with which they have been able to picture to themselves the interrelations of the particular "mechanical model of the universe" they affect, and the abandonment, or rather modification, of this model is, accordingly, much more difficult for them than for younger men less thoroughly steeped in its peculiarities.

The point at present in dispute may be summarised as follows: In the early years of the last century, Dalton revived a theory, originally due to Democritus, that matter was not infinitely divisible, but that it consisted of an aggregate of small particles or atoms which were incapable of being broken up or subdivided by any chemical method. Democritus held that the atoms were uncaused, and had existed from all eternity. Clerk Maxwell called them the foundation stones of the universe, and moved, we believe, rather by a desire to find a purpose in Nature than by purely physical or philosophical considerations, went further by stating that they had all the appearance of being "manufactured articles." In opposition to this, however, many other physicists and chemists, whilst admitting that there was no proof of atomic disintegration in the laboratory, held that it was going much too far to assert its impossibility. The first indication of the existence of particles much smaller than ordinary atoms, was obtained by Sir William Crookes, who was led to believe that in vacuum tubes the discharge was carried by something much less gross than the atoms, and this he called radiant matter. His views, however, met

with little acceptance, especially abroad, but a few years ago, professor J. J. Thomson, by an extraordinarily ingenious series of experiments, succeeded in actually weighing the particles carrying the discharge, and found them to have a mass of about  $\frac{1}{1000}$  that of the atoms of hydrogen. It was later found that these "corpuscles," as Thomson dubbed them, could be obtained from all sorts of materials. If a sheet of zinc is exposed to violet light, they are liberated in large quantities, and under certain circumstances, they are liberated in particularly copious streams from the salts of calcium. About the same time as these researches were in progress, Zeeman showed that whatever it was that produced the light when a salt was highly heated, it was not the atom as a whole, but a very much smaller particle, the calculated mass of which agreed with that of the corpuscles measured by Thomson. Apparently, therefore, the corpuscles formed a constituent of the atom, and on one hypothesis the atom consisted solely of these, there being about 1,000 in an atom of hydrogen. In such a case, atomic disintegration was not only possible, but inevitable, since these charged corpuscles, moving in orbits within the atom at incredible velocities, were each and all acting as radiators, and thus losing their kinetic energy. Recent experiments by Thomson, however, go to prove that the number of corpuscles in the atom has been much over-estimated by the advocates of the above theory; yet, nevertheless, though the number in any atom is apparently of the same order as the atomic weight, the same reasoning holds, and on this theory a time must ultimately be reached when the internal stability of every atom breaks down.

Contemporaneously with much of the two lines of investigation above mentioned, Becquerel made the startling discovery that uranium simultaneously gave rise to a radiation which acted on photographic plates, and therefore possessed a certain energy. Experiment showed that this radiation was apparently independent of exterior influences and that it was of indefinite duration. The Curies subsequently separated from uranium gangue the element radium, which possessed the peculiar properties of uranium in a marvellously enhanced degree. An examination of the radiation emitted by this element, showed that it could be divided into three portions — the so-called  $\alpha$ ,  $\beta$ , and  $\gamma$  rays. The  $\alpha$  rays proved to be positively electrified particles of atomic proportions; the  $\beta$  rays proved to be particles identical with Thomson's corpuscles, whilst the  $\gamma$  rays turned out to be similar to the well-known Röntgen radiation, but to have an extraordinary penetrative power. It was further found that the energy liberated was so great that a mass of radium could raise its own weight of water to boiling point every hour. After measuring the mass of the  $\alpha$  particles, Rutherford suggested that helium was a product of the break up of radium, a supposition shown to be well based by Sir William Ramsay and professor Soddy. In order to unify all the foregoing observations, it was suggested that we had here an instance of that atomic break-up which seemed a necessary consequence of Zeeman's discovery.

This view was bitterly opposed by many chemists and does not commend itself to Lord Kelvin. The chemists maintained that the whole phenomenon was simply a case of the ordinary break-up of a chemical compound, and were able to adduce instances from organic chemistry in which chemical reactions spontaneously occurred under certain conditions, and the rate of change followed exactly similar laws to those found by Rutherford to hold for the decay of the activity of the thorium emanation. In two most essential points, however, the new phenomenon differed from the old. In the first place, the amount of energy liberated was enormously great as compared with that set free in the breakdown of a similar weight of any known chemical compound; and, secondly, the rate of change appeared unaffected by great heat or by the most extreme cold. We believe that some evidence has recently been obtained that the rate of radiation is slightly affected by extreme heat; but the output is the same at the temperature of liquid air, as at a

low red heat, whilst all chemical reactions, on the other hand, are much influenced by such changes of temperature, those in which the rate of change is progressive, rather than explosive, being particularly affected. So far as we are aware, no chemist has attempted to meet either of these objections, nor does Lord Kelvin.

The extraordinary amount of energy liberated by radium led to another fertile suggestion — *viz.*, that a considerable proportion of the flow of heat from the lower strata to the surface of the earth, was due to the presence of radium. For many years, a certain school of thought had derived much mental consolation from the knowledge that physicists and geologists were unable to agree as to the age of the earth. Considering the earth as a mere cooling body, the conductivity of the surface layers of which was known, Lord Kelvin many years ago showed that the date at which the solid crust first began to form was probably not more than 100 million years distant. Similar calculations, made on the assumption that the sun's temperature radiation was due solely to the energy liberated by its shrinkage, led also to the conclusion that it had not been a source of heat and light for more than 15 or 20 million years. Geologists, on the other hand, declared that the record of the rocks pointed to an enormously greater lapse of time between the deposition of the first sedimentary rocks and our era. In 1894, professor Perry showed that the possible age of the earth might be very much greater than calculated by Kelvin and Tait, provided that the interior conductivity was greater than that of the surface rocks. This hypothesis, however, led to the conclusion that the crust must be very thick, which appears to be negated by the wave phenomena observed in earthquakes. If, however, the surface layers of the earth contained an appreciable quantity of radium, the whole difficulty would seem to disappear, and an examination of the surface rocks by Mr. Strutt shows that the amount of radium present is sufficient to fully account for the observed temperature gradient, even if the crust were only a few tens of miles in thickness.

No doubt, this conclusion would be invalidated if, for any reason, the radium in the lower levels ceased to disintegrate, and Lord Kelvin, in one of his several letters to the *Times*, adopts a suggestion of Mr. Douglas Rudge that the enormous pressures to which it is subjected would prevent the display of its peculiar activities. Since, however, these are unchecked by an extreme of cold not excessively far removed from the absolute zero of temperature, there seems no *a priori* ground for believing that they should be checked by pressure. Presumably the idea is to assimilate the break-up of radium to that of calcium carbonate, into lime and carbonic acid gas. This latter reaction is brought to a stop, or, rather, to a state of statical equilibrium, when the pressure of the liberated gas reaches a certain limit. But this limiting pressure is dependent on the temperature, a fact which in itself seems sufficient to negative the suggested analogy. The burden of proof, therefore, would seem to rest on those who assert the influence of pressure, and this proof they have made no attempt to provide. Unless some action of this kind takes place, the presence of radium in the earth's crust, in the quantity actually observed, makes the earth out old enough to suit every requirement of the geologist; and the difficulty with respect to the duration of the sun's light and heat disappears in a similar fashion. It is true that no direct indication of the presence of radium has actually been observed in the solar spectrum; but it will be remembered that helium was first discovered in that luminary, and only detected in our planet many years later. There is strong reason for believing that helium is always a product of radio-activity, and, hence, that the sun contains notable quantities of radio-active bodies.

A curious feature of the derivation of helium from radium, is that helium is not at the outset detectable in the emanation given off, but only makes its appearance after the lapse of some days. Were it involved in the emanation in the same way that sodium is in common salt, it seems

hardly possible that its presence should not be evident in the spectroscope from the very outset though, no doubt, cases are known where the presence of one gas masks the spectrum of another, though present in a fair proportion.

Of course, the theory of atomic disintegration involves, as one of its consequences, that radium is an evanescent element, its life period being some 1,000 to 1,500 years. Hence, unless renewed from some source, it would long ago have vanished from the earth. Its parent substance is supposed to be uranium — an element which is also breaking up, one of its decomposition products being radium. Evidence of this connection is afforded by the observation that the amount of radium present in a uranium mineral is always a constant, though very small fraction of the weight of uranium present. The life period of the latter is enormously greater than that of radium, and possibly the element in question is the residue of some other primordial element which has long since vanished from the face of Nature.

Of course, like any other physical theory, this one of atomic disintegration may, as observations accumulate, prove unequal to the description of new experiments; but as matters stand, no competing explanation of the phenomena involved, seems to cover and unify so wide a range of observed facts; and it will certainly not be abandoned until some other hypothesis is developed which will afford an equally intelligible and adequate model of the internal structure of the atom. The whole question is now in its infancy, and much light on it may be expected during the next few years. Though at present the matter is of no immediate practical importance, the material interests of the race are involved in no remote degree. Our present civilisation is based upon the possession of coal, and the output of mechanical power is increasing rapidly from year to year. In no very distant future, the supply of this at present indispensable commodity will be exhausted, and unless the human race can find some other source of energy, a relapse into barbarism seems inevitable. Recent experiments at Cambridge go to show that it may not prove wholly impossible to unlock the enormous reserves of internal energy which, on the hypothesis now under debate, are assumed to be locked up in the atom, though in the experiments in question, this release of energy was only effected to a degree but little removed from the infinitesimal.

---

[ 625 .145.2 ]

## 2. — Phosphorus in steel rails.

*(The Railway Age.)*

Specifications for steel rails have been the cause of serious disagreements in the committees of every association which has had to do with the adoption of such standards. In 1902, the American Railway Engineering and Maintenance of Way Association adopted a specification for steel rails which makes the limits in the chemical composition for 90 to 100-pound rails, carbon, 0.45 to 0.55; phosphorus, 0.10; silicon, 0.20; manganese, 0.80 to 1.10. This may be taken as representing the chemical specification for most of the rails which have been rolled in this country during the past four or five years. Attention is called to the high phosphorus (0.10) associated with high carbon and high manganese. Prominent members of this association have testified that since the adoption of this specification, each year has produced a worse rail than the previous one. At the March meeting in 1905, Mr. W. R. Webster, chairman of the committee on rails, said, "The question before us is 'brittle rails.' It has been the aim of the committee by the introduction of clauses to regulate the finishing temperature to get good, safe rails from the

ordinary rail steel which is high in phosphorus, but we all appreciate that a better rail can be obtained from steel lower in phosphorus, in that it is less liable to be brittle. This would increase the cost, and we have, therefore, left this matter of phosphorus limit to be adjusted by the individual railway companies with the mills." On account of the large number of rails rejected for brittleness in the drop test, the manufacturers requested, at this meeting, that the drop test for 90 and 100-pound rails be reduced from 22 to 19 feet, but the association refused to do this and made the requirements still more severe, by requiring the sample for drop test to be taken from the rail rolled from the top of the ingot. It was expected that this will serve to reject a larger proportion of piped and brittle rails.

At the June meeting of the American Society for Testing Materials, the committee on rails presented a compromise report proposing to change the drop test, so as to require the sample to be taken from every fifth blow instead of from each blow, also allowing two additional tests if the first failed. This was plainly another attempt of the steel manufacturers to make conditions easier for the acceptance of high-phosphorus rails. The American Society for Testing Materials was wise enough to reject the proposition and passed a resolution referring the subject back to the committee, instructing it to prepare and submit at the next meeting a rail specification which will correct, as far as possible, the defective qualities in rails made under existing specifications.

At the meeting of the American Society of Civil Engineers in June this year, it developed that little progress had been made by the committee on rails, and there was a disagreement in the committee to the extent of presenting a minority report. On account of the difficulty of making satisfactory rails out of high-phosphorus steel, the civil engineers are beginning to think that there must be something wrong with their standard sections for rails. Two of the minority members of the committee hold that standard rail sections should be modified and the other two suggest that modifications of the standard forms of section are advisable, but consider that no change can be made without further investigation of the service value of the present sections. This dissent from the majority report is based mainly on requirements of the specifications for manufacturers' methods and processes, and not on the specifications for testing the finished rails.

The next disagreement that we hear of with regard to rail specifications, is in the joint meeting in London of the American Institute of Mining Engineers and the British Iron and Steel Institute. A paper presented by Mr. Albert Ladd Colby, of New York, making a comparison of American and foreign rail specifications, presented a proposed standard specification to cover American rails rolled for export. In this paper, a rather elaborate apology is made for high phosphorus and the principal part of the discussion of the specification at this meeting of the most eminent ironmasters and metallurgists, was the allowable percentage of phosphorus in steel rails. The chemistry proposed by Mr. Colby for export rails corresponded in phosphorus and other hardeners very closely with that above given, but the English ironmasters objected that 0.10 per cent phosphorus is too high and that portion of the specification was even discredited by the American members. The author himself in his paper says the engineer knows and even the steelmaker grants that phosphorus is the most undesirable constituent of steel, and that when a steel is liable to sudden and frequent shocks it should be low in phosphorus. In the discussion of Mr. Colby's paper, Mr. Windsor Richards said the most interesting point is what shall be the maximum per cent of phosphorus allowable in steel rails. In England, the various engineering societies had agreed on an analysis showing carbon, 0.35 to 0.50; manganese, 0.7 to 1.0; phosphorus, 0.07; sulphur, 0.07. Phosphorus 0.07 was the maximum allowance which the English railroads would allow. Mr. J. E. Stead said that the question of phosphorus was one of the first impor-

tance and all agreed that if the carbon is raised, the bad effect of phosphorus will be more and more pronounced. He considered 0.10 per cent phosphorus too high and it should only be allowed if the other constituents were low. Mr. R. A. Hatfield, the president of the British Iron and Steel Institute, said, "if Mr. Colby had been before the British committee of standards, he would have found difficulty in persuading English engineers to accept 0.10 phosphorus in their specification. The high carbon in the large section rails associated with high phosphorus induces brittleness." In Mr. Colby's paper, it is claimed that rails made to his proposed specifications have been found satisfactory and safe in service, but this is discredited by a letter from Mr. E. F. Kenney, engineer of tests of the Pennsylvania Railroad, who says: "The author has certainly been misinformed regarding the rail situation on American railways. Very convincing testimony has been furnished to the American Society of Civil Engineers and the American Railway Engineering and Maintenance of Way Association that nearly every railway having heavy traffic is suffering greatly from broken rails. The rails are not giving satisfaction as to wear, and any attempt to improve the durability by making them harder is met by a crop of brittle rails. This brittleness is caused by the high-phosphorus content. Rails with lower phosphorus have been made in which the carbon was quite high, thereby getting much better wearing qualities without being brittle; but as long as the phosphorus is kept up to 0.10, it will be impossible to get rails which will wear well without being dangerous. The brittle rail is one of the most important subjects before American railroads to-day."

On account of the majority of test pieces having been taken from the bottom of the ingot where there is least segregation of impurities, and also of the difficulty of getting a fair representative sample from the rail section for analysis, it is probable that a large portion of rails made in recent years contains more than 0.10 per cent phosphorus. Some which failed have been found to contain carbon as high as 0.60 and phosphorus 0.137. High phosphorus is not allowed in American specifications in steel for bridges and ships, and for these purposes it is required that the steel shall be made by the open-hearth process and the phosphorus must not exceed 0.06 for basic and 0.08 for acid steel. There is no place on a railroad where steel in large quantities is subjected to such violent blows as on the rail itself, and of all places it is the one where the phosphorus content should be kept down to the lowest practicable limits. The English ironmasters believe that 0.07 phosphorus is high enough and American rails would be much safer if they were kept down to this figure.

The objections which have been made already to brittle rails have created an opinion among rail-makers themselves that something more should be done in order to make rails containing lower phosphorus. With the supply of native ore high in phosphorus, the best method of producing good steel is by the open-hearth method. The initial difficulty is with the high-phosphorus ore and the pig-iron made from these ores contains 2 or 3 per cent of phosphorus which cannot be reduced much below 0.10 by the basic Bessemer process. The rail manufacturers are probably doing the best they can with the ores and this process, but the evident solution of the problem dealing with high-phosphorus ore is a change to the open-hearth process.

In his presidential address at the meeting referred to, of the Mining Engineers and the Iron and Steel Institute in London, Mr. R. W. Hunt said: "In 1905, there were rolled in the United States 183,264 tons of basic open-hearth rails and while this is small compared with Bessemer tonnage it is the 'handwriting on the wall.' Aside from the comparative merits of Bessemer and basic open-hearth steel, there seems to be no doubt but that America's iron ore conditions will force the growth of the latter process." Since 1899, basic open-hearth rails have been made at the Ensley, Ala., works of the Tennessee Coal & Iron Company. The Colorado Fuel & Iron

Company at Pueblo, Colo., has begun the manufacture of basic open-heart rails on a large scale. The entire rail output of the Dominion Steel Company of Sidney, N. S., is of open-hearth steel, and the United States Steel Corporation in its new works at Gary, Ind., is arranging for the use of eighty 60-ton basic open-hearth furnaces.

[ 625 .251 ]

### 3. — Proportioning brake-shoe pressures to wheel loads.

*(The Railroad Gazette.)*

The layman is dazed, or becomes a radical judge, when doctors disagree. We have had some curious instances of differences of opinion in the conventions of the car builders and master mechanics, but probably none more pronounced than those expressed by two speakers who opened the same topical discussion before the respective associations. In one, the subject was scheduled as "The Desirability of Adjusting Brake Pressure to Light and Loaded Cars," and in the other, as "The Necessity of Proportioning Brake Pressure to Wheel Loads." The first speaker held that there are more and stronger reasons against the desirability of adjusting brake pressures to loads than in favour of it. He also held that, if the retaining valve were to be used as it is intended, the present condition of the equipment would give the engineer entire and full control of the train. These remarks were accepted as the sense of the convention without comment. In short, the Master Car Builders' Association does not consider it desirable to adjust brake pressures to light and loaded cars.

When the same subject was before the Master Mechanics' Association, the speaker took the ground that it was exceedingly desirable to make this adjustment, and called attention to the fact that a brake pressure of 70 per cent on a light car of 50 tons capacity falls to 17 per cent when the car is loaded, making a difference of four to one in the distance that the car would run before being stopped. It was not urged that it would be practicable at present to apply such an adjustable apparatus to general merchandise cars, but that it is quite possible to do so in the case of coal and ore cars that shuttle backwards and forwards in light and loaded service.

This advocacy was likewise allowed to go unchallenged and, by inference, though not by formal action, as in the previous case, it would appear that the Master Mechanics' Association does think it desirable to adjust brake pressures to wheel loads.

It is to be regretted that the subject was not thoroughly discussed in one or other of the associations; for, though only up as a noon-hour discussion, the subject is certainly one of importance. In looking over the records of the past, we find that in 1885, it was urged as advantageous and necessary, to apply brakes to both trucks of a freight car instead of to one only, which was current practice of the time; a suggestion that has been universally adopted in order to increase the total of the braking pressure and thus increase the efficiency. After the Burlington tests, there were a number of attempts to secure an automatic adjustment of the brake-shoe pressures to the requirements of light and loaded cars. As the arrangement by which this was to be accomplished depended upon a mechanical connection on the truck, whereby the leverage was varied in accordance with the compression of the springs, the working was unsatisfactory and the designs were never introduced. This is cited merely to show that as soon as the air-brake had gained a foothold in freight service, men began to think about making it equally efficient upon loaded as upon empty cars. It is difficult to see how there can be any doubt that such action is

desirable. But to discuss the practicability of any device that ~~may~~ be offered, is quite another matter.

A discussion of the question is especially pertinent at the present time, in view of the stresses on the brake-beam. In the report of the committee, attention was called to the changed conditions now existing as compared with those of 1889, when the 7,500 lb. capacity was established as the minimum for a beam. Then the cars ranged in light weight from 18,000 to 34,000 lb., with an average of about 25,000 lb. Now the light weight of high capacity cars may be as much as 45,000 lb. so that taking 70 per cent as the shoe pressure of the earlier cars and 90 per cent as that used on the modern ones, the brake-beam loads have risen from 6,200 to 10,125 lb. This, for empty cars. Now, if a beam is to be designed to carry a 70 per cent pressure of a loaded 50-ton car, it must sustain at least 21,250 lb. if the car weight is placed at 40,000 lb. and a 10 per cent overload is allowed. Great as this burden is, it will be higher still in many cases where the cars are heavier or the weights carried greater; as in the case with cars that are being marked up 10 per cent in nominal capacity where steel wheels are applied.

As strength and freedom from deflection or permanent set under excessive loading are essential qualifications for a brake-beam to meet, the problem is not a simple one. If room is scarce beneath a truck in which to place a beam of 25,000 lb. capacity, when loaded at its center, it may be possible either to discard the beam altogether or else to apply the stresses near the ends and so lighten the structure. The same thing has been done, though for other reasons, on electric cars where all of the space between the axle and the bolster is occupied by the motors. Here two pull rods have been used and a brake obtained that has worked with entire satisfaction. It goes without saying that if it is found to be desirable to put a load of 12,000 or 13,000 lb. on the brake-shoes of each wheel, a means will be found to meet the mechanical requirements.

There is still another aspect of the case that should receive careful consideration, which, at first sight, may seem to make for the use of the lower limit of pressure. This view takes the possible effect on the wheels into consideration. While the effect of the exceedingly high pressures for long distances on grades would undoubtedly be the cause of much cracking, it must be remembered that such a condition is not apt to occur, since such pressures would undoubtedly stop and hold any car on any workable grade. The consequence would be, that the engineer would soon learn to make a lighter application on the loaded trains, thus holding the train under control with no more injury to the wheels than occurs under present conditions of service. It is true that injury might be expected in cases where an engineer, knowing that he had an exceedingly powerful brake available, would allow a train to reach a very high speed on a long and steep grade, and then apply with full force in order to make a stop. This would undoubtedly result in some heating, but whether that would be sufficient, within the comparatively short interval during which it would be in operation to cause injury cannot be predicted accurately from data thus far secured.

It is clear, in view of the great weights carried by present day cars, and the high speeds at which all classes of equipment are likely to be run, together with the effective train control that these conditions demand, should be placed in the hands of the engineer, that this discussion of the desirability of proportioning brake-shoe pressures to light and loaded cars deserves more attention and discussion than was granted it at the recent conventions of the two great mechanical associations.

---

[ 686 .261 ]

#### 4. — The express companies.

(*Railroad Gazette.*)

The organization and operations of the express companies are at the present moment attracting considerable attention. One of the reasons for this is that, by a readjustment which seems probable, the Adams Express Company will lose nearly one-third of its present mileage to a new company called the Northern Express Company. It is probable that this company, organized as the successor of the Northern Pacific Express, is to consolidate the Great Northern Express and the Northern Pacific Express, which now operate each over the road named in its title, and on the expiration shortly of the Adams Express Company's contract with the Chicago, Burlington & Quincy, to add to its mileage that 8,500 mile system, thus consolidating the express business on all of the Hill lines. More important than this in its effect on the express business, determined effort is being made by a considerable proportion of the stockholders of the Wells-Fargo Express Company, another of the four leading companies, to obtain larger dividends. Their contention is that the company is earning at least 30 per cent a year and can conservatively afford to distribute 16 per cent in dividends. This movement has already been successful in securing an increase of the dividend rate from 8 to 10 per cent, and the publication of some slight information about the financial condition of the company. A similar movement has been contemplated by stockholders of the United States Express Company, which now pays 4 per cent dividends, and is alleged to earn at least 18 per cent on its stock. By far the most important of the causes directing attention to the express companies, is the fact that they have been brought under the operation of the new Interstate Commerce law.

The *Wall Street Journal* in a sketch of the four express companies which it is estimated do about 90 per cent of the express business of the country — the Adams, the American, the United States and the Wells-Fargo — shows that the combined mileage of railroad over which they work is 158,000 miles, and that their combined capital is \$48,000,000. The Adams, the American and the United States are joint stock companies. The Wells-Fargo is incorporated in Colorado. These four large companies appear to be in very friendly relations one to another. L. C. Weir, president of the Adams Express, and J. C. Fargo, president of the American, are directors in the United States Express Company. Also nearly one-half of the directors of the four companies are railroad directors. Of the 13 Wells-Fargo directors, eight are officers or directors of railroads; of the nine American, three are railroad directors; of the seven Adams, and of the seven United States, three each are railroad directors. In addition to this interrelation of control, two of the three smaller companies are openly or practically controlled by the larger group. The American Express Company closely controls the National, which has \$5,000,000 capital, and operates over 7,000 miles of road, and the Adams controls the Southern Express Company, which has about the same capitalization and operates a mileage of about 32,000 miles. The Pacific Express, the third of the smaller companies, has a mileage of 22,000, and operates largely west of the Mississippi, its principal railroads being the Union Pacific and the Missouri Pacific. Its board of directors contains four Gould and two Harriman representatives. The mileage of the four most important companies is as follows: Adams, 29,000 miles; United States, 30,000 miles; American, 43,000 miles; Wells-Fargo, 56,000 miles.

The express companies of the United States make no reports of their operations. The only

clue to their gross business lies in figures published by the Interstate Commerce Commission showing the amounts received by the railroads from the express companies, which are, roughly, about 50 per cent of the gross earnings of the express companies. The railroads' income from the express companies has increased from \$28,000,000, in 1900, to \$41,000,000, in 1904. During these five years, the railroads of the country increased their earning capacity 33 per cent, and at the same time enlarged their capitalization by 15 per cent. Basing the estimate on the payments to the railroads, the business of the express companies increased 47 per cent with no increase of capital. Besides these payments of 50 per cent to the railroads, operating expenses probably require another 40 per cent of gross earnings, leaving 10 per cent as the net earnings to the express companies. On this basis, the net earnings of the express companies have increased from \$5,000,000, in 1900, to \$7,500,000, in 1904. Thus although no definite figures are obtainable, it is abundantly evident that the express business of the country is highly profitable.

The whole question of larger disbursements to stockholders, appears to be bound up in the question of publicity for express company accounts. At present, no returns whatever are made, and the stockholders are left to conjecture as to the real earnings of their companies. This is the dangerous feature in express company management as it exists to-day. Leaving out of consideration the question of a parcels post operated by the government which, if the example of similar service abroad is any precedent, could carry a large part of the express business at a much lower rate, the time has passed when so important a public business should be conducted so secretly. Not only the stockholders of the express companies, but those of the railroads, have the right to know under exactly what arrangements this highest grade traffic is being carried on. On the expiration of a contract with an express company, the stockholders of the railroad should be informed of the conditions, and have a chance to form an intelligent opinion as to whether it is to the advantage of the railroad to continue the contract, and if so, on what terms. The present day agitation against corporations, has been largely caused by secrecy such as this, with regard to matters vital to the financial interests of stockholders — a condition always likely to result in manipulation by an inside ring — and it seems reasonable to expect that the veil of mystery hitherto surrounding the express business will soon be drawn aside. The Interstate Commerce Commission will no doubt now require the express companies to make full reports of their business and of the arrangements under which it is done. Such statements will make clear the whole question of whether larger dividends should be paid, and, from the railroad standpoint, of whether the present express contracts are equitable.

The following table gives the most important railroads over which the principal express companies operate. In cases where more than one company operates over a road, the most important company is mentioned.

*Wells-Fargo Express Company.*

Atchison, Topeka & Santa Fe System.  
Southern Pacific System.  
Chicago, Rock Island & Pacific.  
St. Louis & San Francisco.  
Erie.  
Chicago Great Western.  
Denver & Rio Grande System.  
Colorado & Southern.

El Paso & South-Western System.  
Kansas City Southern.  
Mexican Central.  
Mexican International.  
San Antonio & Aransas Pass.  
Vera Cruz & Pacific.  
Tehuantepec National.

*American Express Company.*

New York Central Lines <sup>(1)</sup> .	Central Vermont.
Chicago & North-Western System.	Chicago, Indianapolis & Louisville.
Illinois Central System.	Buffalo, Rochester & Pittsburg.
Boston & Maine System.	Bangor & Aroostook.
Missouri, Kansas & Texas.	

*United States Express Company.*

Chicago, Milwaukee & St. Paul.	Chicago & Alton.
Philadelphia & Reading System.	Delaware, Lackawanna & Western.
Baltimore & Ohio System.	Lehigh Valley.
Cincinnati, Hamilton & Dayton and Pere Marquette.	Ohio Central Lines.
	Lake Erie & Western.

*Adams Express Company.*

Pennsylvania Lines.	Chesapeake & Ohio.
New York, New Haven & Hartford.	Richmond, Fredericksburg & Potomac.
Chicago, Burlington & Quincy.	Western Maryland.
Iowa Central and Minneapolis & St. Louis.	Kansas City, Mexico & Orient.

*Southern Express Company.*

Operates over all important railroads in southern territory, including the Norfolk & Western. Adams Express also operates over Louisville & Nashville.

*Pacific Express Company.*

Union Pacific.	International & Great Northern.
Missouri Pacific.	Texas & Pacific.
Wabash System.	Texas Central.
St. Louis South-Western.	Detroit, Toledo & Ironton System.

*National Express Company.*

Delaware & Hudson,	Toledo, St. Louis & Western.
New York, Chicago & St. Louis.	Wisconsin Central.

Also operates jointly with the American over several railroads.

[ 624 .131.2 ]

5. — Limits for weight on axles.

(*The Railway Age.*)

For years prior to 1895 artificial and arbitrary limits for the wheel pressure on the rail were imposed by the chief engineers of American railroads, and while in the earlier days these limits

<sup>(1)</sup> Except Lake Erie & Western.

may have been justified, the practice was continued so long, that in later years it had a serious effect on the growth of the locomotive. In reviewing this development, the impression gained is that the limitations of load on axles simply stunted the natural growth of the locomotive which should have accompanied the improvement in track and the use of heavier rail.

For ten years, from 1880 to 1890, the tractive power of locomotives increased but slightly, and during the following decade, 1890 to 1900, while some progress was made in developing engines of greater power, this development was accompanied by a corresponding increase in total weight of the engine. The necessity for strict economy in operation following the lean years after 1893 resulted in the introduction of tonnage rating and with it restrictions as to wheel pressures and axle loads seem to have been thrown aside, and the American locomotive then increased more rapidly in power and weight. Since 1900, the effect of the restrictions as to load on axle in previous years appears to have resulted in a slow development on the old lines and efficiency as to ratio of power to weight remains stationary, while but little improvement is seen in refinement of design in American locomotives during this period.

The limitations of loads on axles which have been adopted by various foreign countries, while perhaps unduly low in some instances, have had an important effect on the design of rolling-stock, especially locomotives. It has often been remarked, at the time of international exhibitions, where locomotives from different countries have been seen side by side, that the machinery of foreign locomotives is much lighter than that of American locomotives having equivalent cylinders. In fact, the data relating to weights of foreign engines show them to have an important advantage in this respect over those built in America.

At the Milan exposition, the attention which has been given to the matter of dead weight in the design of foreign locomotives is quite marked. The allowable load per axle in Austria, Germany and Italy is about 15 tons, in France 16 tons, and in Belgium 18 tons per axle, but there is now a disposition to make a more liberal allowance in most of these countries. With these low limitations, it is remarkable what has been accomplished in designing the large locomotives exhibited at Milan and that without increasing the number of wheels and axles. The four-cylinder *Atlantic* Hannover locomotive which was shown at Milan, weighs only 136,640 pounds or 16  $\frac{3}{4}$  tons per axle. It has a total heating surface of 2,580 square feet and weighs 53 pounds per square foot of heating surface. There is also at the same exposition a four-cylinder *Atlantic* locomotive built by the Hungarian State Railways at Buda-Pesth. In a test on level this engine has hauled 357 tons at a speed of 68.5 miles per hour. The weight of the engine is 166,432 pounds or 17.7 tons per axle. The total heating surface is 2,823 square feet and the weight of the engine per square foot of heating surface is 58 pounds.

In England, there is apparently no official limitation to the rail pressure per wheel, but in the development of large passenger locomotives the track clearances have necessitated the use of four cylinders. The four-cylinder balanced compound designed by Mr. Wilson Worsdell for the North Eastern Railway has a weight of 22 tons per axle and this is probably the maximum now used on British railways. In Belgium, a four-cylinder simple locomotive with six drivers built for the Belgian State Railways, has a weight of 19 tons per axle and its tractive power is 31,500 pounds. This engine has a superheater and its weight per square foot of heating surface is 107 pounds.

On the line between Paris and Calais, the balanced compounds weigh 140,000 pounds and haul trains weighing 295 tons on a grade of  $\frac{1}{2}$  per cent at a speed of 52 miles per hour. It is admitted that we have no locomotives of American build which will nearly equal this performance.

The Pennsylvania de Glehn locomotive is a good example of careful attention to keeping down dead weight, especially in the moving machinery. This engine weighs 164,000 pounds, 22 tons per driving axle and 60 pounds per square foot of heating surface. The above figures may be compared to recent designs for heavy balanced compounds used on American lines. The Erie compound *Atlantic* weighs 28.75 tons per driving axle, and the Pennsylvania Railroad compound *Atlantic*, built by the Baldwin Locomotive Works, weighs 30 tons per axle. This engine weighs 200,000 pounds and has a total heating surface of 2,864 square feet, the ratio being about 70 pounds per square foot. These weights per axle are nearly double the limits imposed by Germany and Austria, but the engines are not twice as powerful as the examples we have named.

It may be said that a definite weight on drivers is necessary for adhesion in large locomotives, but by careful attention to design it is often possible to keep the total weight down so that an *Atlantic* type locomotive with only four drivers will perform the required service without resorting to the *Pacific* type with six drivers. Some improvement has been made in reducing the weight of valve gears of American locomotives, by abandoning eccentrics and placing the valve gear on the outside. This change has incidentally reduced the weight of the moving parts, but it was not made specially for this purpose, but because heavy eccentrics could not be operated successfully and they became so troublesome that it was not possible to keep them in order in the cramped position between the frames.

The aim of American builders has apparently been to produce the heaviest locomotive possible, while no effort is directed to the production of the most powerful locomotive with a given weight. With competing locomotive builders, it ought to be possible to obtain some improvement in efficiency on a weight basis, as well as in the mere matter of cost. Locomotive specifications could require a certain ratio of total weight of engine to square foot of heating surface, and to pounds of tractive power. Little or no effort appears to be directed to the limitation of weight in the construction of American passenger cars, and the excessive weight of modern equipment is largely the result of this neglect. While safety should be a first consideration, careful attention to design of structural details would often save a considerable amount of dead weight without any sacrifice of the safety features.

---

# List of the papers published for the Fifth Session.

ENGLISH EDITIONS (IN RED COVERS).

NUMBER of the pamphlet.	NUMBER of the Question.	TITLE OF THE QUESTION.	CONTENTS.	PRICE.	
				Excluding postage.	Including postage.
1	XX	Brakes for light railways . . . . .	Report, by Mr. Ploeg . . . . . Addenda, by the same.	FR. C. 1 50	FR. G. 1 60
2	V	Boilers, fire-boxes and tubes . . . . .	Report, by Mr. Ed. Sauvage . . . . .	3 -	3 15
3	XVI	Decimal system. . . . .	— by Mr. J.-L. Wilkinson . . . . .	1 50	1 60
4	XIX	Light railway shops . . . . .	— by Mr. Terzi . . . . .	1 50	1 60
5	XV	The twenty-four hours day. . . . .	— by Messrs. Scolari and Rocca. . . . .	1 50	1 60
6	XIII	Organisation. . . . .	2 <sup>nd</sup> report (for English speaking countries), by Mr. Harrison. . . . .	1 50	1 60
7	X	Station working . . . . .	2 <sup>nd</sup> report on parts A and B (for English speak- ing countries), by Mr. Turner . . . . .	2 25	2 40
8	XI	Signals . . . . .	2 <sup>nd</sup> report (for English speaking countries), by Mr. Thompson . . . . .	2 25	2 40
9	I	Strengthening of permanent way in view of increased speed of trains.	1 <sup>st</sup> note, by Mr. Raynar Wilson. . . . . 2 <sup>nd</sup> report (for English speaking countries), by Mr. William Hunt. . . . .	3 -	3 20
10	VI	Express locomotives . . . . .	Addenda by the same. . . . .	7 50	7 90
11	II	Places in permanent way requiring special atten- tion. . . . .	Report, by Mr. Aspinall. . . . . — by Mr. Sabouret . . . . .	1 50	1 60
12	XIII	Organisation. . . . .	1 <sup>st</sup> report (for non-English speaking countries), by Mr. Duca. . . . .	9 -	9 40
13	VII	Rolling stock for express trains . . . . .	Report, by Mr. C.-A. Park. . . . .	2 -	2 10
14	III	Junctions. . . . .	— by Mr. Zanotta. . . . .	3 -	3 15
15	...	The history, organisation and results of the Inter- national Railway Congress.	Note, by Mr. A. Dubois. . . . .	2 50	2 65
16	IX	Acceleration of transport of merchandis . . . . .	Report, by Mr. H. Lambert . . . . .	1 50	1 60
17	XII	Cartage and delivery. . . . .	Report, by Mr. H. Twelvrees . . . . . 1 <sup>st</sup> note, by the Belgian State Railways Ad- ministration. . . . .	1 50	1 60
18	XI (See also N° 9)	Signals . . . . .	2 <sup>nd</sup> note, by the Western Railway of France Administration. . . . . 1 <sup>st</sup> Report (for non-English speaking countries), by Mr. Motte. . . . .	3 75	3 95
19	XVII-A	Light feeder lines (contributive traffic). . . . .	2 <sup>nd</sup> note, by the Mediterranean Railway Company (Italy). . . . .		
20	XIV	Settlement of disputes . . . . .	3 <sup>rd</sup> note, by Mr. Theo. N. Ely. . . . . 4 <sup>th</sup> — by the American Railway Association (Messrs. A.-W. Sullivan and F.-A. Delano). . . . .		
21	XVIII	The working of light railways by leasing com- panies. . . . .	5 <sup>th</sup> note, by Mr. Robert Pitcairn. . . . . 6 <sup>th</sup> — by Mr. A.-T. Dice. . . . .	1 50	1 60
22	IV	Construction and tests of metallic bridges . . . . .	Report, by Mr. De Backer. . . . .	1 50	1 60
23	X	Station working. (Methods of accelerating the shunting of trucks.) . . . . .	— by Mr. De Perl. . . . .	1 50	1 60
		Station working. (Employment of mechanical and electrical appliances in shunting.) . . . . .	— by Mr. de Burlet . . . . .	3 75	3 95
24	...	Railway progress in the Dominion of Canada . . . . .	Note, by Mr. W.-M. Acworth. . . . .	4 50	4 75
25	I (See also N° 9)	Strengthening of permanent way in view of increased speed of trains.	Report, by Mr. Max Euler von Leber. . . . . 1 <sup>st</sup> report on Part A (for non-English speaking countries), by Mr. J. de Richter . . . . .	6 -	6 30
26	XVII-B	Relaxation of normal requirements for light rail ways. . . . .	1 <sup>st</sup> report on Part B (for non-English speaking countries), by Messrs. Eug. Sartiaux and A. von Boschan. . . . .		
27	VIII	Electric traction . . . . .	1 <sup>st</sup> note, on Part B, by Mr. Ast 2 <sup>nd</sup> — by the Administration of the « Kaiser Ferdinand Nordbahn ». . . . .	1 50	1 60
28	XIV (See also N° 20)	Settlement of disputes . . . . .	Memorandum, by the Hon. Sir Charles Tupper. Report, by Mr. Ast (first part) . . . . .	2 25	2 40
29	I (See also N° 9 and 25)	Strengthening of permanent way in view of increased speed of trains.	Report, by Messrs. Humphreys-Owen and P.-W. Meik. . . . .	3 -	3 15
30	A	Technical information on the breaking of steel rails. — on the current cost of metal- lic compared with wooden sleepers.	1 <sup>st</sup> note, by Mr. E.-A. Ziffer. . . . . 2 <sup>nd</sup> — — — — — 3 <sup>rd</sup> — by the Hon. Thomas C. Farrer. . . . .	6 50	6 80
31	B	Technical information on the life of wooden sleepers of different kinds, not pickled or pickled according to various processes.	Report, by Mr. Auvert . . . . . 1 <sup>st</sup> note, by the Western of France Railway. 2 <sup>nd</sup> — by the Northern of France Railway. 3 <sup>rd</sup> — by Mr. Ernest Gerard . . . . .	1 50	1 55
32	C	Technical information on locomotive crank axles.	Note, by Mr. Chas. J. Owens. . . . .	1 50	1 55
33	D	Technical information on the breaking of steel rails. — on the current cost of metal- lic compared with wooden sleepers.	Report, by Mr. Ast second part). . . . .	3 50	3 70
34	E	Technical information on locomotive fire-boxes . . . . .	Report, by Mr. Brucka . . . . .	1 50	60
35	F	Technical information on locomotive boilers . . . . .	— by Mr. Kowalski . . . . .	3 -	
36	G	Technical information on the lubrication of rolling stock. . . . .	— by Mr. V. Herzenstein . . . . .	7 -	
37	H and I	Technical information on shunting engines and on the movement of the staff in different coun- tries. . . . .	As the information collected on this question was very incomplete, it was not dealt with. Report, by Mr. Hodeige. . . . . — by Mr. Belleruche . . . . . — by Mr. Hubert . . . . .	6 - 3 50 3 50	6 30 3 70 3 70

N. B. — The numbering of the pamphlets (see first col.) issued in French and English is not the same. The English editions are in red covers and the French editions in brown covers.

CONTENTS.	PAGES.	NUMBERS OF PLATES AND FIGURES.	NUMBERS of the DECIMAL CLASSIFICATION.
I. — The Kapteyn apparatus for recording continuous brake trials, by A. FÜHR. . . . .	1647	Figs. 1 to 10, pp. 1649 to 1654.	625 .251
II. — The gasoline car for interurban service, by F. W. HILD . . .	1657	Figs. 1 and 2, pp. 1663 and 1668.	621 .335
III. — Recent high-speed trials of steam locomotives . . . . .	1672	...	621 .131.3 & 656 .222.1
IV. — The passenger service on the Ceylon railways, by Messrs. BLUM and E. GIESE . . . . .	1679	Figs. 1 to 6, pp. 1680 to 1684.	385 .09.1 (.54)
V. — PROCEEDINGS OF THE SEVENTH SESSION (3 <sup>rd</sup> section, working): Question XII : Suburban traffic. Sectional discussion. Report of the 3 <sup>rd</sup> section. Discussion at the general meeting. Conclusions . . . . .	1685	...	656 .23
VI. — PROCEEDINGS OF THE SEVENTH SESSION (4 <sup>th</sup> section, general): Question XIII : Slow freight rates. Sectional discussion. Report of the 4 <sup>th</sup> section. Discussion at the general meeting. Conclusions . . . . .	1711	...	656 .235
Appendix : Note on the freight rates on the Indian railways, by William A. DRING . . . . .	1741	...	656 .235 (.54)
VII. — MISCELLANEOUS INFORMATION :			
1. The radium controversy . . . . .	1748	...	54
2. Phosphorus in steel rails . . . . .	1751	...	625 .143.2
3. Proportioning brake-shoe pressures to wheel loads . . .	1754	...	625 .251
4. The express companies . . . . .	1756	...	656 .261
5. Limits for weight on axles. . . . .	1758	...	621 .131.2
VIII. — MONTHLY BIBLIOGRAPHY OF RAILWAYS :			
I. Bibliography of books . . . . .	107	...	016 .385. (02)
II. — of periodicals . . . . .	109	...	016 .385. (05)

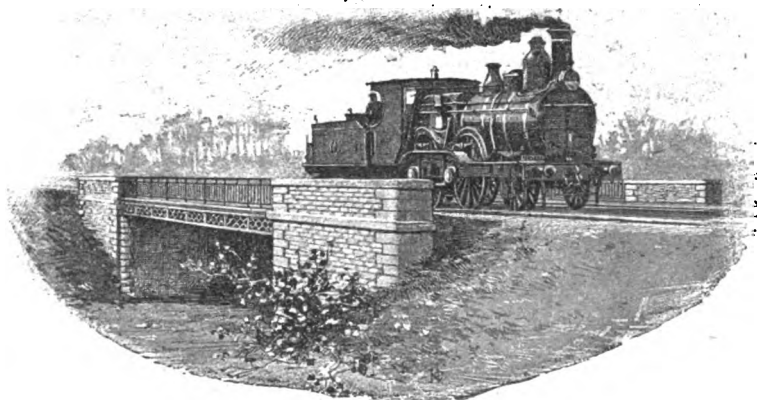
Econ3008.2

YEARLY SUBSCRIPTION (Jan. to Dec. *only*) PAYABLE IN ADVANCE, £1.4s. = \$6.

Vol. XX. — No. 12. — December, 1906. 11<sup>th</sup> Year of the English Edition.

---

**BULLETIN**  
**OF THE**  
**INTERNATIONAL RAILWAY CONGRESS**  
**ASSOCIATION**  
**(ENGLISH EDITION)**  
**[ 385. (05) ]**



Editorial communications should be addressed  
to the Permanent Commission (Executive Committee) of the International Railway Congress Association  
rue de Louvain, 11, Brussels.

**BRUSSELS**  
**PUBLISHED BY P. WEISSENBRUCH, PRINTER TO THE KING**  
**49, rue du Poinçon.**

**LONDON**  
**P. S. KING AND SON, PARLIAMENTARY AND GENERAL BOOKSELLERS**  
**2 and 4, Great Smith Street, Westminster, S. W.**

**The Permanent Commission of the Association is not responsible for the opinions expressed  
in the articles published in the BULLETIN.**

# NOTICE

---

All editorial communications intended for the *Bulletin* should be addressed to Mr. Louis Weissenbruch, General Secretary of the Permanent Committee, International Railway Congress Association, 11, rue de Louvain, Brussels. The *Bulletin*, which is published in monthly numbers forming an annual volume of more than 800 pages, contains the whole of the proceedings and publications of the Congress of every kind. Copies are sent gratuitously to all the Companies, members of the Congress, at the rate of one copy for each delegate which the Company is entitled to send to a Congress meeting with one extra copy for the Company's own library.

The *Bulletin* can be supplied at the rate of 25 francs = £1 = \$5 per annum, not including postage; or 30 francs = £1.4s. = \$6 including postage to subscribers who send their subscriptions in advance by cheque or postal order direct to the publisher, Paul Weissenbruch, 49, rue du Poinçon, Brussels.

---

*N. B.* — The annual subscription, which must be paid in advance and dates from the January of the year for which the subscription is sent, does not vary even when the number of pages in the year's issue greatly exceeds 800 pages (the 1900 volume of the English edition consisted of 3988 pages). But the price of each monthly number, if bought separately, is fixed according to the number of pages it contains as follows:

2s. (50 cents) per 72 pages not including postage.

It is therefore evident that there is a great gain in subscribing for the whole year.

---

The whole years 1896, 1897, 1898, 1899, 1900, 1901, 1902, 1903, 1904 and 1905 of the English edition of the *Bulletin* containing 1,370, 1,824, 1,634, 1,695, 3,988, 2,734, 1,129, 1,353, 2,066 and 2,626 pages, may be obtained each at 35 francs = £1.8s. = \$7, including postage.

---

Previous volumes of the *Bulletin*, published in French only, contained 1,574, 1,196, 2,194, 1,576, 749, 4,114, 1,124, 1,118, 3,812 and 1,632 pages, illustrated with numerous plates and diagrams, for the years 1887 to 1896 respectively may be obtained at the same price.

---

**PAPERS PUBLISHED FOR THE FIFTH SESSION :** A detailed list of the papers, notes, and technical information, prepared for the London meeting, is given on the third page of the cover.

Copies may be had on application to the publisher, 49, rue du Poinçon, enclosing remittance of the price as given in the list opposite each paper on the third page of the cover. (*N. B.* 1 franc = 10d. = 20 cents.)

BULLETIN  
OF THE  
INTERNATIONAL RAILWAY CONGRESS  
ASSOCIATION  
(ENGLISH EDITION)

---

[ 388 .14 (.73) ]

GOVERNMENTAL REGULATION IN THE UNITED STATES,

By LOGAN G. McPHERSON,

LECTURER ON TRANSPORTATION JOHN OPKINS UNIVERSITY OF BALTIMORE (MARYLAND).

---

In pursuance of the purpose to grant to the Federal Government the least measure of power consistent with what was then deemed its effectiveness, the framers of the American Constitution decreed to Congress only that degree of control over the conduct of transportation, which may be deduced from the following clause : Section VIII. The Congress shall have power... Clause 3 —. To regulate commerce with foreign nations, and among the several States and with the Indian tribes.

At that time when but an insignificant fraction of the products of any one State was shipped to and marketed in another, it goes without saying that the adjustment of the new government was not designed to meet the present conditions under which the commodities consumed within the State of production are but an insignificant fraction of those that are carried across State boundaries.

The early concern of the State governments with the provision of transportation facilities did not extend beyond the building and maintenance of post-roads and of canals. For these, charters were granted when necessary. The charters for the first railroads were issued by the respective States, and this custom has continued until the present. Even although the nation, to encourage the development of outlying regions, in former years granted thousands of acres of the public domain to companies that built railroads through the wilderness and over the uninhabited plains, these companies obtained their charters from individual States.

From 1830 until checked by the panic of 1857, the construction of the railroads was rapid, the extent of their mileage soon surpassing that of the canals. Their shares and securities were eagerly taken by individuals, counties and towns and in

cases by States. There was little or no attempt at adjustment by legislation of the differences that arose between the carriers, their patrons, and the bodies politic. This was the period of *laissez faire*.

The renewed activity that succeeded the Civil War resulted in the extension of railroads far beyond the immediate needs of the regions which they served. The ensuing strife for traffic led to discriminations between shippers and communities that in many cases were outrageous, and to rate wars that were burdensome both to the railroads and the communities. As neither shipper nor railroad knew what rates rival shippers were paying or rival railroads were charging, each shipper would strive to undersell and each railroad to undercharge the other, and this led to a chaotic condition entailing loss upon all concerned. Different States began to establish railroad commissions with powers varying from that of investigation and conciliation to that of prescribing rates. The wrath of the people, that was not by any means entirely without justification, caused certain of the Western States to enact overly stringent legislation known as the "granger laws", which after a few years were found to work more injury through the repression of activity than had been entailed by the preceding lack of legislative restraint, and they were modified or repealed. State commissions have, however, been established at one time and another, until now in thirty-five States, there are commissions of various kinds with widely different powers. The effectiveness of a commission depends of course not only upon the statute but upon the personnel. In certain States, their performance has been admirable; in others their activity is negligible; in yet others, by hard and fast rules, they have retarded the development of the State which created them.

By act of Congress passed in 1866, the railroads of the different States were authorized to join in the formation of through lines for the carriage of freight and passengers from one State to another. This legislation, authorizing the through billing and through ticketing of through traffic, practically marks the development of the strife between the railroads carrying such traffic, the giving of rebates, the securing of business by fair means or foul. As the railroads hold their charters from State governments, and as there is no Federal law save such as is enacted by Congress, there was practically no appeal to the courts in so far as interstate traffic was concerned, although one or two judicial decisions are of record indicating that there was not entire absence of such relief had it been sought.

The waging of warfare and the indulgence in piratical practices was if anything more disastrous to the railroads than to their patrons, and the administrative officers of the rival lines endeavored incessantly to terminate the one and exterminate the other by agreements as to rates and stipulations as to their uniformity. The desire to obtain business, and the pressure of communities and patrons, however, was stronger than the so-called "gentlemen's agreements" none of which endured for very long. As a further step toward enforcing agreements as to rates and practices, there arose the device of apportioning to each of the competing lines between principal centers, a percentage, of the competitive traffic. If a line secured

less than its agreed percentage, the difference was made up by the other lines; if it secured more, it was obliged to divide the excess between the other lines. Such an arrangement was known as a pool. Sometimes the division was made between the competing lines on the basis of tonnage, — a tonnage pool; sometimes on the basis of revenue, — a money pool. Heavy deposits were made by each of the agreeing lines to be surrendered as forfeit in case of violation of the agreement. The first traffic pool was that entered into by the lines between Chicago and Omaha in 1870. The railroads of the South, that had resumed their activity under especially distressing and demoralizing conditions, entered in 1875 into an agreement drawn by the master hand of Albert Fink, who at a later date became the Commissioner of the Trunk Line Association which was formed in 1877.

Although perfection was not attained in the operation of the pools, a certain stability was given to rates, and unjust discriminations were materially diminished. During the seventeen years of their existence, the average ton-mile rates decreased from nearly 2 cents to about 1 cent, a sufficient proof that the decline in rates was not arrested because of the pools. The continual improvements in construction of road and equipment and in methods of operation decreased the cost of transportation, while the efforts of traffic managers to increase the traffic by extending markets lowered the rates.

The agreements and practices unfortunately designated by the word “pool” were however never favoured by the people in general. It was thought that they entrenched the railroads in monopoly and there was a violent clamor for their abolition. At that time, there was as there is now a confusion of ideas between the making of rates and the granting of rebates, a misconception of the source of the genuine abuses in railroad practice. There was public agitation unquestionably due in part to objectionable and often tyrannical conditions fostered by some railroads at some times, but also in large part due to unreasoning condemnation of many practices that have since been proved unobjectionable and often beneficial. This and the fact that there really was no Federal legislation covering interstate traffic led to the passage of the Interstate Commerce Act taking effect April 5, 1887.

This act which practically applied the principles of the common law, which inhere in the unlimited jurisdiction of the State courts, to the regulation of interstate traffic by the Federal courts provided :

1° That charges for transportation must be reasonable and just; prohibiting any unjust discrimination by special rates, rebates or other devices and any undue or unreasonable preferences;

2° That there should not be a greater charge for a short haul than for a long haul over the same line in the same direction under substantially similar circumstances and conditions;

3° Prohibited the pooling of freights and the division of earnings;

4° Prohibited any device to prevent the continuous carriage of freights;

5° Provided for the publicity and filing with the Commission of all tariffs;

6° The Interstate Commerce Commission created by the Act is given power to investigate complaints against carriers, and to make reports of its investigation in writing;

7° The Interstate Commerce Commission is authorized, in case it finds that the carrier has violated the law, to order it to desist and make reparation for injury done. In case these orders are not obeyed, the Commission is empowered to proceed in a summary way to have the Circuit Court of the United States enforce them.

It will be observed that there is nothing in this Act conferring power upon the Commission to fix a specific rate; it has many times been stated by those who framed the bill, that there was no intention to confer this power, and their statement is borne out by the reports of the debate in Congress at the time.

The effectiveness of the Interstate Commerce Commission is shown by the fact that from its organization on April 8, 1887, to December 31, 1904, it had received four thousand and twelve complaints, an average of about two hundred a year, of which three thousand two hundred and twenty-three were informal and settled by friendly mediation. Of the seven hundred and eighty-nine formal complaints, almost half were settled by agreement or withdrawn. Of the three hundred and fifty-nine cases of which the Commission has disposed, in the two hundred and ninety-seven formal decisions which it has rendered, a trifle more than one half have been decided in favour of the complainants, the remainder having been dismissed. In but forty-five cases have the railroads refused or neglected to obey the orders of the Commission. Of these forty-five cases which have been appealed, the courts have rendered decisions in thirty-five, and in but three of these has the order of the Commission been sustained.

Notwithstanding this record, the Interstate Commerce Commission during the last several years, has fomented agitation for the increase of its powers, asserting that the right to determine and make effective a specific rate was conferred upon it by the original Act and taken away after its exercise for ten years. The Commission by formal resolution directed its secretary to conduct a propaganda towards having this power conferred upon it.

About two years ago, the Commission caused to be circulated statements that because of increases in freight charges, the railroads had obtained for the year 1903 a revenue exceeding by 155 million dollars that which would have been obtained under the rates charged in 1899. These and other figures which were embodied in a report to the United States Senate, entitled Senate Document 257, the railroads at once condemned, as having been obtained by inaccurate calculation from incorrect premises. The railroads state that the increased revenue was but about 68 million dollars; that the comparison was with the year when rates owing to the depression following the year 1893 had been reduced to the lowest level in the history of American railroads; that the rates for 1903 were less than for 1895 or

any preceding year, and that moreover the increase, which was but a trifle over 5 per cent, was but nominal in that the prices for material consumed by the railways, and the wages paid by them, had increased in the same period from 15 to 25 per cent.

Although there had been little if any complaint as to the charge of exorbitant rates by the railroads in the preceding decade, it seldom, if ever being claimed any where by anybody that the rates of the American railroads have prohibited traffic from moving; although the amendment to the Interstate Commerce Law known as the Elkins Act approved February 19, 1903, materially strengthened the procedure against railroads guilty or suspected to be guilty of rebates and unjust discriminations, the agitation fomented by the Commission for the increase of its powers, together with the clamor stimulated by certain dissatisfied and for the most part unimportant shippers, who had failed to adjust themselves to the economic current, led to the passages by the House of Representatives in the spring of 1905, of the Esch-Townsend Bill which gave the Commission authority to fix a rate and to put it in effect, which gave the Commission authority over any "rate, regulation or practice" of a railroad company.

When this bill reached the Senate, it was referred to its Committee on Interstate Commerce, which arranged for a series of hearings of the representatives of all interests involved. The testimony taken by that Committee formed the basis of the elaborate discussion which continued throughout the press and at public meetings until the convening of the fifty-ninth Congress in December, 1905. The message of the President to Congress at that time stated that legislation was needed not so much to prevent the imposition of rates unreasonable in themselves, but to prevent unjust discriminations between persons and places, and that therefore, the Interstate Commerce Commission should be empowered to determine upon complaint what should be the maximum rate thereafter to be charged by the carrier, which should be in effect unless reversed by the courts.

There was introduced in the House of Representatives and passed by that body on February 8, 1906, the Hepburn Bill which contained provision for the fixing of a maximum rate by the Commission; but did not modify the existing law in regard to rebates, and made no provision for the appeal by a railroad to the Federal courts in case it should desire to contest a rate fixing order.

The Hepburn Bill was referred by the Senate to the Committee on Interstate Commerce, which after deliberation extending over several weeks, reported it without amendment and without recommendation. Thereupon ensued a memorable debate which, however, was but little concerned with the economic phases of transportation or with the voluminous evidence taken by the Senate Committee on the general subject during its hearings of the previous spring. The speeches dwelt almost entirely upon the legal aspects it being evident that the Senate desired to pass an adequate bill that would be constitutional; many doubts had been expressed that the Hepburn Bill would meet this test.

During the session numerous bills, other than that proposed by Representative Hepburn, were introduced in both Houses, the most conspicuous bearing the name of Senator Foraker. The Senior Senator from Ohio frankly opposed the Hepburn Bill from the start. In his opinion the clause of the Constitution according to Congress the right to "regulate" commerce between the States and territories could not be construed into authorizing Congress to definitely fix, or delegate the power to fix, under any circumstance, a specific rate for transportation. He held that relief from unjust practices of the railroads and abuses in their administration should be obtained by direct resort to the courts; and his bill provided that at the instance of a complainant, there should be instant prosecution at the expense of the government, before a Federal court, which would restrain an extortionate rate, rebate or discrimination.

The discussion, however, centered upon the Hepburn Bill, which had been passed by the House and was favoured by the President of the United States. With various amendments, it was passed by the Senate, and after prolonged consideration by the Conference Committee was finally passed and approved June 29. By joint resolution it took effect sixty days thereafter, on August 28, 1906.

The Bill provides :

a) That as "common carriers" under the Interstate Commerce law shall be included companies transporting oil by pipe lines, express companies, sleeping car companies; all switches, tracks, terminal facilities; and that "transportation" under the law shall include all cars regardless of their ownership, and all service in transit.

This extension of the law is intended in the case of sleeping car and express companies to secure a greater publicity for their tariffs and operations; in the case of companies transporting oil by pipe lines, to prevent discrimination of the companies owning the pipe lines in favour of their own product. Switches, tracks, terminal facilities and all cars — all of which are largely owned by the industrial corporations — are included because they have frequently been used as agencies to obtain an undue proportion of the regular railroad rates, which has been equivalent of course to the securing of cut rates and rebates.

b) Prohibits the issue of passes, with certain specified exceptions that cover mainly employees, either direct or collateral; and for religious and charitable purposes; fixing a penalty in case of violation that shall apply to both the giver and the recipient.

The issue of passes to favoured shippers, that had been a great abuse in previous years, was much mitigated by the passage of the original Interstate Commerce Act. There remained the issue of passes to public officers and for political purposes in general. This issue which became a source of great abuse both by the politicians and by the railroad companies, to which it has been a tremendous burden, is now forbidden.

c) Makes it unlawful after May 1, 1908, for any railroad company to transport for sale any commodities in which it may have a proprietary interest, except lumber and its products.

This prohibition has grown out of the fact that in a few cases railroad companies have concealed what in actuality has been a cut rate, by marking off the difference on the books of the merchandise department. In nearly every case, this device has been resorted to to conceal cut rates on coal from mines operated by a separate company subsidiary to and controlled by the railroad company. As however in several cases a railroad company is permitted by its original charter granted by a State to own coal lands, it remains to be seen what will be the constitutional construction of this provision.

It is difficult to see how the original grant of the right to own coal made by the State issuing a charter can be annulled, or in practice how the shipment of such coal can be confined within State boundaries. If property in coal lands continues to be a right of one railroad company, it is difficult to see how it can be denied to another and a competing company.

d) Provides that a common carrier shall provide, when, practicable and upon reasonable terms, a switch connection for any applicant who shall furnish sufficient business to justify its operation.

Here again the animus has been the complaint of would be coal operators that one or another railroad company would not afford them facilities for shipment. Bituminous coal is so plentiful in certain regions of the United States and the opening of a mine attended with so little expense, that there is the incessant attempt during times of prosperity for small operators with insufficient capital and insufficient facilities in every respect to enter the market. It is indisputable that the railroad companies, for the sake of preventing the demoralization that inevitably follows such haphazard attempts, as well as to conserve the orderly use of their equipment, have exercised discretion in regard to the provision of shipping facilities.

e) Makes more explicit the specification as to the filing of tariffs, especially providing for the posting and filing of through tariffs, and the acceptance of the through rates quoted in such tariffs by such carriers participating therein; fixing penalty for violation.

This amendment makes no change in the spirit and not a great deal in the letter of the provision of the original law.

f) Provides that " every person or corporation, whether carrier or shipper, who shall knowingly offer, grant, give or solicit, or accept, or receive rebates, concessions, or discrimination shall be deemed guilty of a misdemeanor, and on conviction thereof shall be punished by a fine of not less than 1,000 or more than 20,000 dollars ". Moreover, any person, whether officer or director, agent or employee convicted of such misdemeanor " shall be liable to imprisonment in the

penitentiary for a term not exceeding two years, or both fine and imprisonment in the discretion of the court ”.

This is a drastic provision against the insidious abuse that has admittedly been the greatest evil in the conduct of railroad transportation in the United States. It was inserted in the bill by the United States Senate, and is entirely in line with the recommendation and request of the representative railroad managers.

*g)* Provides for the publication of the reports and the decisions of the Commission and their acceptance as evidence.

*h)* Empowers the Commission, if upon complaint it finds that a rate, or any regulation of practice affecting a rate is “ unjust or unreasonable, or unjustly discriminatory, or unduly preferential, or prejudicial ” to determine and prescribe a maximum rate to be charged thereafter and modify the regulation or practice pertaining thereto. This includes the prescription of a through rate and the apportionment thereof between carriers parties thereto. Orders of the Commission shall take effect in not less than thirty days and continue in force not exceeding two years, unless suspended or set aside by the Commission or a court of competent jurisdiction.

The form and phrase of this amendment were the crux of the controversy that raged for a year and a half. It was at first proposed by the administration that the Interstate Commerce Commission be given final power, upon complaint, to fix a specific rate. The railroads strenuously objected to the enactment of such legislation pointing out that it would not only impair their administration but work to the injury of the commerce of the country. The amendment as passed, however, effects a radical change. Under the original Interstate Commerce Law the burden of proof in the courts, that an order was just, laid with the Commission. This amendment throws upon a railroad company not desiring to obey an order of the Commission the burden of appeal to the courts and proof therein that the order is unjust.

*i)* Empowers the Commission to award damages against a carrier in favour of a complainant.

*j)* Provides for forfeit to the United States, in case of neglect to obey an order of the Commission, in the sum of 5,000 dollars for each offense, each violation and each day of its continuance to be deemed a separate offense.

This is obviously a very heavy penalty designed to prevent any procrastination on the part of a railroad company in carrying out an order of the Commission.

*k)* Empowers the Commission to apply to a circuit court for the enforcement of its order, other than for the payment of money; for the appeal by either party to the Supreme Court of the United States; and that no order of the Commission shall be suspended or restrained, except on hearing, after not less than five days notice to the Commission.

l) Provides for the rehearing by the Commission, upon application, at its discretion.

m) Authorizes the Commission to require annual reports from all common carriers, that shall contain specified information; to prescribe the form of any and all accounts, records and memoranda to be kept by carriers, making it unlawful for the carriers to keep any other accounts, records, or memoranda than those prescribed and approved by the Commission; provides that all accounts of the carriers shall be open to the inspection of the special agents, or examiners employed by the Commission.

It was feared by some of the railroads that the prohibition from keeping "any other accounts, records or memoranda than those prescribed and approved by the Commission", would interfere with the elaborate memoranda used as the basis of the several systems of statistics to which the foremost of the American railroads admittedly owe a large share of their excellence. It is not impossible that friction may arise upon this point, but the prospect at present is that the Commission is not inclined to the arbitrary exercise of its power under this provision.

n) Provides that a common carrier issuing a through bill of lading shall be responsible for loss, damage or injury to the property covered thereby upon the lines of any company over which it may pass, leaving it to the line issuing the way bill, to gain recovery from another line upon which loss, damage or injury may have occurred.

This amendment was enacted at the request of the bankers, who desired that a bill of lading be an entirely safe and negotiable security. The railroads were inclined to protest, but it is not likely that they will contest the point further.

o) Enlarges the Interstate Commerce Commission from five to seven members, with terms of seven years, increasing the salary from 7,500 to 10,000 dollars per annum.

Throughout the public discussion prior to the convening of the fifty-ninth Congress, the railroads had declared that rebates were practically of the past; that there was abundant provision in the Interstate Commerce law and the Elkins law for the detection, prosecution and punishment of offenders in this respect if the Interstate Commerce Commission would avail of the authority conferred upon it under these laws. The former claim was largely disproved and the latter substantiated during the months immediately preceding the enactment of the Hepburn Bill by the fact that the Commission, through investigation and prosecution more vigorous than had been its wont, discovered many cases of rebates and brought the offenders to penalty. Inasmuch as the railroads had besought Congress, for their own protection, to strengthen the law against rebates, if such strengthening were possible, it is fair to presume that the drastic provisions inserted by the Senate in the Hepburn Bill meet with the concurrence and the acceptance of the railroads and the public alike.

Investigation of the Commission in the year prior to the enactment of the Hepburn

Bill also unearthed other practices of certain railroads that were condemned by the public in general; their exposure seems certain to act as a substantial preventative of their recurrence.

There is reason to hope that the diffusion of knowledge as to the underlying principles of correct railroad practice, together with well-balanced action of the Commission under the new law, will lead to a better and wider accord between those charged with the administration of the railroads, the public whom they serve, and the government to whom they are responsible.

---

## BUFFERS

### DURING SHUNTING OPERATIONS AND DURING THE BRAKING OF LONG TRAINS,

By J. DOYEN,

PRINCIPAL ENGINEER, BELGIAN STATE RAILWAY.

---

Fig. 1, p. 1775.

---

The buffer springs hitherto used are evidently too weak to prevent the injurious effect of the blows which wagons give each other.

Hardly any attempts have been made to make them stronger, the reason being that there was no particular advantage in having a spring capable of taking up the whole energy developed by the collision of wagons. The springs give out, in expanding, very nearly all the work they have momentarily taken up, and it is a disadvantage to have this act on the drawgear, which is comparatively weak, when it can be absorbed by much stronger appliances : the buffers, driven home, and the underframe of the wagons.

Unfortunately these appliances, although they are strong, have but little elasticity, and the result is violent shocks which break the buffer springs, the axle guards and the axle boxes, injure the bodies, displace the frames and cause much damage to the load.

Westinghouse, in inventing his friction gear, was the first to produce a buffer which transformed the greater part of the energy concerned into heat, so that only a small proportion acted on the drawgear.

It is possible to calculate what amount of work a buffer must be able to take up in order to satisfy the requirements of actual practice. Now we know that these requirements are specially great during shunting operations and during the application of continuous brakes on long trains.

I

**Buffers and shunting operations.**

We are now going to determine how much work the buffers must take up in order that a wagon of mass  $M$  going at a velocity of  $v_0$  may without shock run up against a wagon of mass  $m$ , standing still.

Let :

$a$  = the initial stress of the springs;

$e$  = their travel in metres;

$f$  = their deflection in metres per kilogram;

$v$  = the speed which the wagon run against assumes after the buffers have been in contact a time  $t$ ;

$v'$  = the speed the other wagon still has after that time  $t$ ;

$x$  = the travel of each buffer during this time  $t$ .

The force acting during this time  $t$  is at every moment equal to

$$F = a + \frac{x}{f}.$$

Therefore, in the case of the wagon which originally was standing still,

$$mv = \int Fdt = at + \int \frac{x}{f} dt,$$

whence

$$v = \frac{a}{m} t + \frac{1}{mf} \int xdt,$$

and, in the case of the other wagon,

$$M(v_0 - v') = at + \int \frac{x}{f} dt,$$

whence

$$v' = v_0 - \frac{a}{M} t - \frac{1}{Mf} \int xdt.$$

It follows that

$$v' - v = v_0 - \frac{M+m}{Mm} \left( at + \frac{1}{f} \int xdt \right) . . . . . (1)$$

But  $v' - v$  gives, at every moment, the speed with which the drawgear between the two wagons is compressed.

We thus obtain :

$$(v^2 - v) dt = 2dx.$$

Now if we take

$$v^2 - v = z,$$

then

$$dt = \frac{2dx}{z},$$

and equation (I) becomes :

$$\begin{aligned} z &= v_0 - \frac{M+m}{Mm} \left( at + \frac{2}{f} \int \frac{x dx}{z} \right), \\ dz &= - \frac{M+m}{Mm} \left( a \frac{2dx}{z} + \frac{2}{f} \int \frac{x dx}{z} \right), \\ z dz &= - \frac{2(M+m)}{Mm} \left( a dx + \frac{1}{f} \int x dx \right), \\ \frac{z^2}{2} &= C - \frac{2(M+m)}{Mm} \left( ax + \frac{x^2}{2f} \right), \end{aligned}$$

when

$$x = 0, \quad z = v_0$$

and consequently the constant

$$C = \frac{v_0^2}{2},$$

whence

$$\frac{z^2}{2} = \frac{v_0^2}{2} - \frac{2(M+m)}{Mm} \left( ax + \frac{x^2}{2f} \right).$$

In order that contact may ensue without shock, it is evidently enough for  $z$  to equal 0 when  $x = e$ .

What a good buffer ought to do, is shown by the equation

$$v_0^2 = \frac{4(M+m)}{Mm} \left( ae + \frac{e^2}{2f} \right),$$

which may be put in the form :

$$e \left( a + \frac{e}{2f} \right) = \frac{Mm}{4(M+m)} v_0^2 \quad \dots \dots \dots (II)$$

or

$$e \left( \frac{2a + \frac{e}{f}}{2} \right) = \frac{Mm}{4(M+m)} v_0^2.$$

This shows clearly that the first expression of the equation represents the work to which the buffer is equal.

In the case of two wagons having a total mass of  $M + m$ , the amount of work the buffers must be able to take up is a maximum when  $M = m$ .

From equation (II) it follows that :

$$a + \frac{e}{f} = \frac{Mmv_0^2}{2(M+m)e} - a.$$

The first expression in this equation represents the stress  $\psi$  on the buffers when at the end of their travel.

When  $M = m$ , then

$$\psi = \frac{M}{4e} v_0^2 - a.$$

*Example.* — Let :

$M = 3,000$  (corresponding to a 20-ton wagon with four wheels, loaded);

$e = 0.075$ ;

$a = 2,000$  kilograms for the two buffers at the one end of a wagon.

Then

$$\psi = 10,000 v_0^2 - a$$

and when

$$v_0 = 1.50 \text{ metres,}$$

which is an ordinary walking speed,

$$\psi = 20,500,$$

which gives for each of the two buffers at the one end of a wagon, 10,250 kilograms.

## II

### Buffers and continuous brakes.

Recent experiments made on the Belgian State Railway have shown that a very simple modification in the Westinghouse brake gear makes it possible to brake a 50-wagon train by means of strong and inexpensive apparatus. A report of these very important trials will be issued later on.

Here we will merely state that a trouble with the new brake has been the fracture of couplings, and that we have to determine, what buffers are required in the case of a 50-wagon train, equipped with the continuous brake, if the locomotive and train part suddenly.

Let :

OAB be the indicator diagram of the first brake cylinder;

O'A'B' be the indicator diagram of the  $n^{\text{th}}$  and last cylinder;

$s_1$ , the area of diagram OABCO in kilogram-seconds;

$s_n$ , the area of diagram O'A'B'C'O' in kilogram-seconds;

OC =  $t_1$ , the time from the commencement of action in the first cylinder till the pressure is full on;

O'C' =  $t_n$ , the corresponding time for the last cylinder;

T, the time for transmitting the action, by means of the main pipe, from one wagon to the next,  
so that OO' =  $(n - 1) T$ ;

F, the retarding action per wagon.

As F is at any given moment proportional to the pressure in the brake cylinder, the ordinates of the diagram below (fig. 1) give at each moment the value of F.

We may remark that the time during which the buffers are compressed is included between the moment O, when the action begins in the first cylinder, and the moment C' when pressure is full on in the last wagon and consequently in all the wagons of the train. The length of this time is  $(n - 1) T + t_n$ .

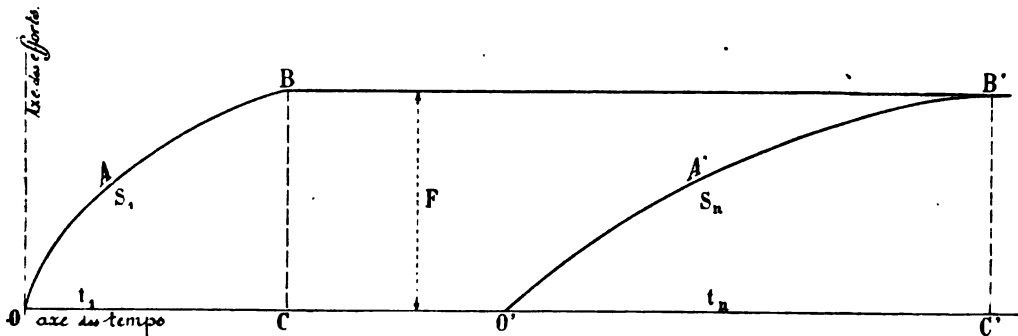


Fig. 1.

Explanation of French terms : Axe des efforts = Stress ordinate. — Axe des temps = Time ordinate.

The amount of motion

$$m(v_0 - v) = \int F dt$$

lost by the first wagon during this time, is measured by the area of diagram OABB'C'O.

This is equal to

$$OABC + BC(00' + O'C' - OC),$$

that is to say to

$$s_1 + F[(n - 1)T + t_n - t_1],$$

whereas the amount lost by the last wagon during the same time is  $s_n$ .

The difference between these two amounts is thus :

$$F [(n-1) T + t_n - t_1] + s_1 - s_n.$$

As this difference is produced during the time  $(n-1) T + t_n$ , it follows that the mean force which produces the recoil of the first wagon relatively to the last wagon, during the compression of the train, is :

$$\varphi_1 = \frac{F [(n-1) T + t_n - t_1] + s_1 - s_n}{(n-1) T + t_n},$$

which can be put in the form :

$$\varphi_1 = \frac{F \left[ T + \frac{t_n - t_1}{n-1} - \frac{s_n - s_1}{F(n-1)} \right]}{T + \frac{t_n}{n-1}}.$$

Similarly we obtain for the mean force which acted on each of the wagons during its recoil relatively to the last wagon :

$$\varphi_2 = \frac{F \left[ T + \frac{t_n - t_2}{n-2} - \frac{s_n - s_2}{F(n-2)} \right]}{T + \frac{t_n}{n-2}}$$

⋮

and

$$\varphi_{n-1} = \frac{F \left[ T + t_n - t_{n-1} - \frac{s_n - s_{n-1}}{F} \right]}{T + t_n}.$$

It will be seen that the exact determination of the values  $\varphi_1, \varphi_2 \dots \varphi_{n-1}$  depends on knowing the areas  $s_1, s_2 \dots s_n$  and the times  $t_1, t_2 \dots t_n$ ; that is to say, on the indicator diagrams showing the pressures in each of the cylinders.

But a much smaller number of diagrams may be worked from, if we assume that between two given diagrams the areas  $s$  and the times  $t$  vary by a constant amount from one wagon to the next.

A fair result may even be obtained from the diagrams of the first and last cylinders only; and in order to simplify the explanation of the method, we will take this case.

We thus have

$$t_1, t_n; \quad s_1, s_n;$$

and we assume that if

$$t_n - t_1 = (n-1) \alpha,$$

then :

$$\begin{aligned} t_n - t_2 &= (n - 2) \alpha, \\ t_n - t_3 &= (n - 3) \alpha, \\ &\vdots \\ t_n - t_{n-1} &= \alpha. \end{aligned}$$

And similarly that if

$$s_n - s_1 = (n - 1) \beta F,$$

then :

$$\begin{aligned} s_n - s_2 &= (n - 2) \beta F, \\ s_n - s_3 &= (n - 3) \beta F, \\ &\vdots \\ s_n - s_{n-1} &= \beta F. \end{aligned}$$

The equations for the mean forces then become :

$$\begin{aligned} \varphi_1 &= F \frac{T + \alpha - \beta}{T + \frac{t_n}{n-1}}, \\ \varphi_2 &= F \frac{T + \alpha - \beta}{T + \frac{t_n}{n-2}}, \\ &\vdots \\ \varphi_{n-1} &= F \frac{T + \alpha - \beta}{T + t_n}. \end{aligned}$$

Let us put  $l$  for the length, in metres, by which each of the couplings can contract;  $l$  is equal to twice the travel of the buffers plus the distance between the buffers when the couplings are stretched; for at the moment when drawgear breaks the couplings are evidently stretched.

During the compression of the train, the recoil of the first wagon relatively to the last is thus equal to  $(n - 1) l$ , and as the force  $\varphi_1$  has acted over this distance the work produced by the recoil is

$$\varphi_1 (n - 1) l.$$

The corresponding amounts of work, for the other wagons, are

$$\begin{aligned} \varphi_2 (n - 2) l \\ \vdots \end{aligned}$$

and

$$\varphi_{n-1} l.$$

Now if we put

$$\varphi_1 (n - 1) l + \varphi_2 (n - 2) l + \dots + \varphi_{n-1} l = Q \quad \dots \dots \dots (III)$$

Then  $Q$ , the sum of these different amounts of work, will be the amount, in kilogram-metres, which the buffers must be able to take up, in order that the braking may take place without shock.

Thus each coupling must be able to take up  $\frac{Q}{n-1}$  kilogram-metres, that is to say, each of the four buffers  $\frac{Q}{4(n-1)}$  kilogram-metres.

If  $a$  is the initial stress,  $\psi$  the stress at the end of the travel, and  $e$  the travel of the buffers, then :

$$\frac{a + \psi}{2} e = \frac{Q}{4(n-1)},$$

$$\psi = \frac{Q}{2(n-1)e} - a \dots \dots \dots (IV)$$

Equation III will be discussed in the report of the brake trials, referred to above.

If we determine the value of  $\psi$  by means of equation IV, measuring  $T$ ,  $t$ ,  $s$  on the diagrams obtained with air brakes, we find that the buffers now used are not equal to their work.

It is certainly possible to improve brakes still further; but there is no doubt that buffers of high final resistance, necessary for shunting purposes, will much facilitate the solution of the problem and that the greater the amount of work the buffers can take up, the more powerful and effective the brakes can be.



## LOCOMOTIVE TESTS,

By Dr. W. F. M. GOSS,

Compilation from a publication by the Pennsylvania Railroad entitled : "Locomotive tests and exhibits. The Pennsylvania Railroad System at the Louisiana Purchase Exposition".

Figs. 1 to 25, pp. 1784 to 1815.

### The Pennsylvania locomotive tests.

The Pennsylvania Railroad System has recently brought to a conclusion a research of unusual magnitude and value. Beginning with an announcement of its plans in the spring of 1903<sup>(1)</sup>, it has designed and constructed a locomotive testing plant and has equipped it with accessory apparatus of every sort; it has secured the co-operation of national engineering societies in the formation of an advisory committee which has assisted in directing the more scientific phases of the work; and it has made its plant accessible to other railway companies which have furnished locomotives for the tests. In the working out of its plans, the testing plant was made to constitute a part of the Pennsylvania's exhibit at the Louisiana Purchase Exposition, where during the period of the exposition, tests were made upon a considerable number of locomotives under the unrestricted inspection of the public. In outlining the tests, it was early decided that no time should be spent in an experimental study of details, but that the effort should be to establish, by carefully chosen methods, the performance under ordinary working conditions of a number of typical locomotives. As a result of this plan, the performance of eight different locomotives has been determined. A description of these and an elaborate presentation of the data derived from the one hundred and three tests which were run, together with conclusions based upon these data, constitute portions of a handsome volume of more than seven hundred pages, recently issued by the Pennsylvania Railroad System. It is from the pages of this volume that the material herein contained has been derived.

The fuel used for all tests was a bituminous coal of high quality. The heating value of a pound of dry coal averaged more than 14,000 B. T. U. Its composition was as follows :

Fixed carbon . . . . .	75.85
Volatile combustible . . . . .	16.25
Ash . . . . .	7.00
Moisture . . . . .	0.90
	100.00

(1) Vide *Bulletin of the Railway Congress*, No. 1, January, 1904, p. 88, and No. 4, April, 1904, p. 335.

All locomotives tested were run in accord with a fixed schedule. To avoid irregularities arising from differences in the diameter of drivers, the speeds of this schedule were selected with reference to the revolutions of the drivers. The standard speeds for freight locomotives were 40, 80 and 160 and 240 revolutions per minute, and for passenger locomotives 80, 160, 260 and 320 revolutions per minute. The provisions for observing the action of the locomotives under test were elaborate, and all instruments occupied similar locations upon all machines. The thoroughness which characterized the work may be judged from the fact that the log-sheets of each test contained 399 items, many of which were the averaged values of many observations. Four of the locomotives tested were for freight and four were for passenger service. Two of the freight locomotives were simple and two were compound, while all of the passenger locomotives were of the four-cylinder balanced compound type, one being of French design and manufacture, one of German and two of American. It happened that three of the locomotives tested — a simple engine, a two cylinder compound and a four-cylinder compound — were built by the American Locomotive Company. The following tabulated statement will be convenient for reference.

#### THE LOCOMOTIVES TESTED.

Presented for test by	Designating number.	Service.	Wheel arrangement.	Description.	By whom manufactured.
Pennsylvania Railroad . . .	1499	Freight.	2-2-0	Simple.	Pennsylvania Railroad Company.
Lake Shore & Michigan Southern Railway . . . . .	734	—	2-8-0	—	American Locomotive Company.
Michigan Central Railroad . .	585	—	2-8-0	Two-cylinder compound.	American Locomotive Company.
Atchison, Topeka & Santa Fe Railway . . . . .	929	—	2-10-2	Four-cylinder tandem compound.	Baldwin Locomotive Works.
Atchison, Topeka & Santa Fe Railway . . . . .	535	Passenger.	4-4-2	Four-cylinder balanced compound.	Baldwin Locomotive Works.
Hanover Locomotive Works .	628	—	4-4-2	Four-cylinder balanced compound with superheater.	Hanover Locomotive Works.
New York Central & Hudson River Railroad . . . . .	3000	—	4-4-2	Four-cylinder balanced compound.	American Locomotive Company.
Pennsylvania Railroad . . .	2512	—	4-1-1	Four-cylinder balanced compound.	Alsacienne Company.

#### RESOLUTIONS OF THE ADVISORY COMMITTEE.

At its concluding meeting, held in Philadelphia, June 12<sup>th</sup>, 1905, the following preamble and resolutions were adopted by the Advisory Committee :

THAT WHEREAS : The Advisory Committee, representing various scientific and technical interests in the tests of locomotives at the Louisiana Purchase Exposition, having completed its formal work, and desiring to express its appreciation of the action of the Pennsylvania

Railroad System in conceiving, planning and executing these tests, now makes of record the fact that :

“ The Pennsylvania Railroad System has brought into existence an entirely new testing plant, designed for mounting either freight or passenger locomotives, and capable of absorbing for an indefinite period the maximum power of a modern locomotive, when running at any rate of speed between 10 and 75 miles per hour ;

“ It has caused to be designed and constructed a dynamometer capable of registering the tractive power of the heaviest locomotives, and at the same time so sensitive as to indicate the slightest variation in the force it may exert ;

“ It has purchased and standardized instruments and apparatus for use in securing all data which has been deemed to be of scientific interest ;

“ It has organized a complete corps of observers, engineers and computers to carry out the tests, and to record, tabulate and analyze the results ;

“ It has invited and secured the co-operation of scientific and technical men of this and other countries to assist in placing the tests upon the highest scientific plane possible in such work ;

“ It has overcome difficulties, in many cases perplexing and serious, incident to the carrying out of such a work as a part of a great International Exposition ;

“ It has, as a result of its effort, defined the action of eight different typical locomotives as regards the performance of the boiler, the engine and of the locomotive as a whole, under many different conditions of operation, making of record a mass of information concerning the economic performance of the modern locomotive of great immediate value, and supplying a basis of comparison which will prove useful for many years to come ;

“ It has met the expense of equipping and operating the plant with an unstinted hand, always holding considerations of cost subordinate to the definite object of making the tests as complete and valuable as possible, notwithstanding the fact that the amounts involved have been far greater than have ever been appropriated to any similar undertaking ; and

“ It has undertaken a broad plan of publication which is to result in making all its data derived from tests, and all conclusions based thereon, together with a description of methods and means employed, all in great detail, accessible to railroad officials and locomotive designers throughout the world ;

Therefore, Be It Resolved,

“ That the Advisory Committee expresses its appreciation of the part taken by the organized staff concerned in conducting this work ;

“ It recognizes that special credit is due to Mr. J. J. Turner, third vice-president, and Mr. Theo. N. Ely, chief of motive power, for their efforts in securing the interest and the favourable action of the Pennsylvania Railroad System in behalf of the proposed work, for the broad views which have prompted them in giving it their general direction, and for the interest they have shown in the maintenance of the high standards which have marked its progress ;

“ To Mr. F. D. Casanave, for the able manner in which he has effected a working organization, for his successful efforts in securing locomotives to be tested, for the skill, earnestness and freedom from friction with which he has managed the entire work ;

“ To Mr. A. W. Gibbs, for his enthusiastic personal support and for the fullness with which he has made available the resources of the Motive Power Department ;

“ To Mr. A. S. Vogt, for a design of testing plant of unusual beauty and perfection of details,

and of such excellence in operation that under severe conditions of service, interruptions were more frequently due to locomotive defects than to difficulties with the plant;

“ To Mr. E. D. Nelson, for the efficiency with which he organized and managed the expert staff, and for the ability shown in dealing with all scientific questions involved;

“ To Mr. G. L. Wall and his efficient staff of assistants for the devotion shown in the operation of the plant, their ability and determination in overcoming difficulties, their skill in maintaining running conditions, and their painstaking efforts in securing accuracy in results.”

W. F. M. GOSS,  
H. H. VAUGHAN,  
J. E. SAGUE,  
E. M. HERR,  
F. H. CLARK,  
C. H. QUERREAU,  
H. V. WILLE,  
W. A. SMITH.

*Advisory Committee.*

---

#### **Simple consolidation locomotive Pennsylvania Railroad No. 1499.**

The first locomotive placed on the testing plant was built by the Pennsylvania Railroad and was of a standard (2-8-0) type employed in heavy freight service. It belonged to the “ H6a class ” according to the railroad company’s classification and was designated as No. 1499. The locomotive was received at St. Louis directly from the Altoona shops where it had been built. Unlike other locomotives tested, it had not been prepared for the test by the preliminary service on the road, but as the first machine upon the testing plant, it was employed to break in the plant and in this manner was worked under steam for a considerable time before being subjected to tests for record.

The boiler pressure during the several tests of this locomotive, as averaged from all observations taken, ranged from 177 to 203 pounds. The minimum evaporation per hour for any test was 10,828 pounds and the maximum 25,896 pounds. The latter performance is equivalent to an evaporation per foot of heating surface per hour of 12.39 pounds and to the development of 891.3 boiler horse-power. Coal was fired at rates per hour ranging from 1,116 pounds to 4,252 pounds. The maximum evaporation per pound of dry coal was 11.53 pounds.

The maximum indicated power of engine 1499 was 1,036 and its cylinder performance was the more efficient of the two-simple locomotives tested. It developed a horse power for one hour on 23.43 pounds of dry steam. It happened, however, that losses in the transmission of power from the cylinders to the draw-bar, arising from the friction of its machinery, were comparatively large, due in part doubtless to the newness of the locomotive when tested. Its machine efficiency varied between the limits of 72.89 per cent and 84.82 per cent. Losses from this source reached the high limit of 248 horse-power at a speed of 160 revolutions per minute.

With reference to the performance of the locomotive as a whole, it appears that the maximum average draw-bar pull for any test was 22,078 pounds which was maintained at a nominal speed of 80 revolutions per minute. Higher draw-bar pulls were not attempted because of fluctuations in the pressure of the water supply, by which friction brakes were controlled. This variable

**Table I.**  
**Pennsylvania Railroad Locomotive No. 1499.**  
*Built at Juniata Shops of the Pennsylvania Railroad, Altoona, Pa., March, 1904.*

SUMMARY OF DATA.

number of test.	RUNNING CONDITIONS.				BOILER PERFORMANCE.					POWER.			WATER AND FUEL CONSUMPTION.		
	Revolutions per minute.	Miles per hour.	Cut-off percent of stroke.	Throttle opening.	Equivalent evaporation in pounds per hour.	Equivalent evaporation per square foot heating surface per hour, in pounds.	Boiler horse power.	Pounds of dry coal per hour.	Equivalent evaporation per pound of dry coal.	Indicated horse power.	Machine friction horse power.	Dynamometer pull, in pounds.	Steam per I. H. P. per hour, in pounds.	Coal per I. H. P. per hour, in pounds.	Coal per D. H. P. per hour, in pounds.
	I	II	III	IV	V	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI
110	40.3	6.7	22.44	Full.	12,870	5.18	373	1,161	11.53	366	85	15,706	28.33	2.94	3.84
111	40.4	6.7	30.45	—	15,372	6.19	445	1,368	11.24	454	81	20,864	27.29	2.91	3.54
103	92.7	15.4	22.80	—	20,581	8.29	596	2,089	9.85	650	133	12,587	25.51	3.13	3.94
109	81.6	13.5	20.88	—	18,375	7.40	533	2,094	8.78	588	106	13,314	25.31	3.47	4.24
112	79.7	13.2	29.24	—	22,825	9.20	662	2,767	8.25	779	150	17,831	23.92	3.48	4.30
118	80.7	13.4	39.34	—	28,102	11.32	815	3,448	8.15	930	141	22,078	24.70	3.63	4.28
108	79.7	13.2	41.44	—	26,895	10.83	780	3,940	6.83	895	162	20,779	24.69	4.33	5.29
116	120.1	20.0	31.33	—	27,856	11.22	807	3,516	7.92	975	187	14,813	23.43	3.54	4.38
115	120.6	20.0	33.96	—	29,900	12.04	867	4,041	7.40	1,086	187	15,883	23.74	3.84	4.69
102	160.3	26.6	22.16	—	24,410	9.83	707	3,271	7.46	803	188	8,663	24.78	4.00	5.22
105	157.6	26.2	28.03	—	27,513	11.08	797	3,829	7.19	951	260	9,929	23.73	3.96	5.43
113	158.7	26.4	30.12	—	28,427	11.45	824	4,001	7.11	968	206	10,835	24.17	4.07	5.17
106	160.9	26.7	32.91	—	30,943	12.47	897	4,627	6.69	1,050	276	10,863	24.15	4.34	5.89
117	160.6	26.7	35.30	Partial.	30,747	12.39	891	4,163	7.39	1,024	248	10,902	24.69	4.00	5.28
101	160.5	26.7	42.14	—	28,203	11.36	817	4,252	6.63	852	203	9,418	27.30	4.93	6.48
104	160.8	26.7	45.09	—	28,424	11.45	824	3,882	7.32	803	207	8,366	29.19	4.77	6.44
114	160.8	26.7	52.05	—	28,583	11.51	828	3,723	7.68	682	170	7,182	34.62	5.40	7.19

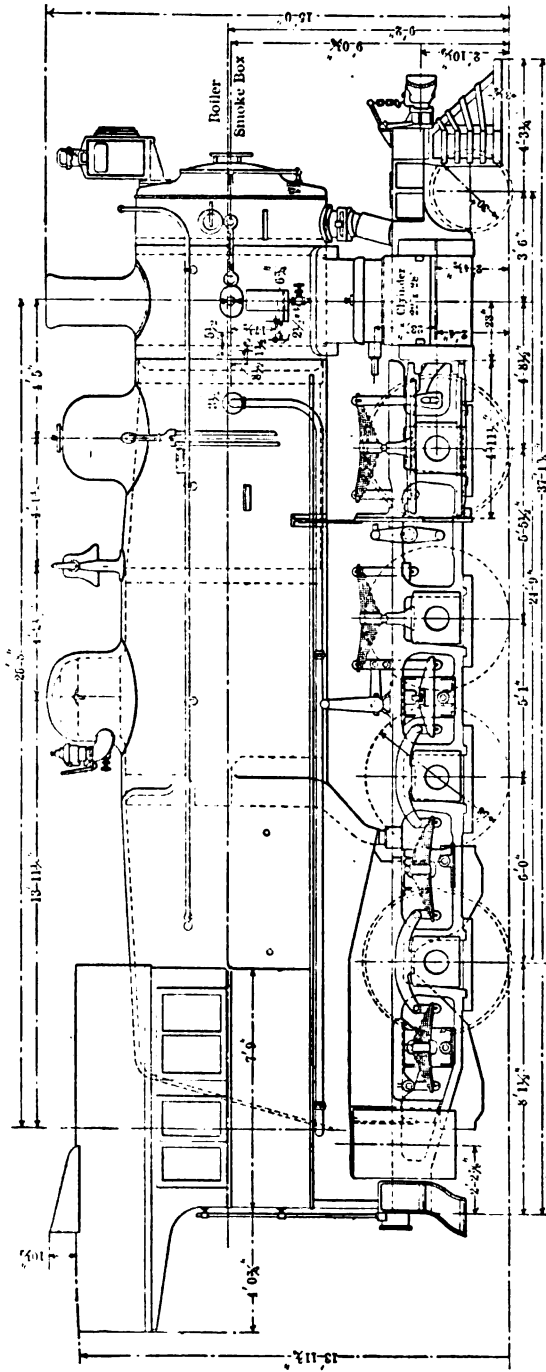


Fig. 1. — Locomotive No. 1499, Pennsylvania Railroad.

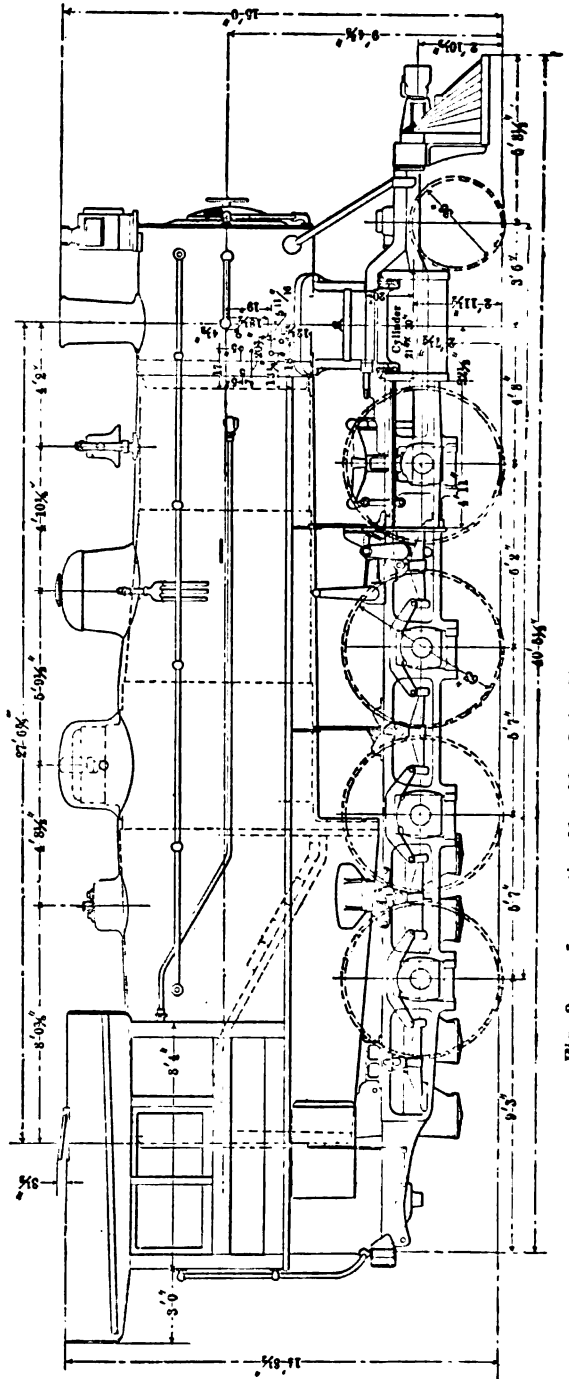


Fig. 2. — Locomotive No. 734, Lake Shore & Michigan Southern Railway.

water pressure which for a time introduced serious problems in the operation of the plant made it difficult to control the load on the brakes, and when the load was heavy caused frequent slipping of wheels. The maximum dynamometer horse-power was 848·6. The coal per dynamometer horse-power ranged between the limits of 3·54 pounds and 6·48 pounds. The results show that the coal consumption per unit power developed at the draw-bar increased as the speed increased. A summary of the data from all the tests is set forth in table I.

*Principal dimensions of locomotive No. 1499.*

Total weight, lb. . . . .	194,200
Weight on drivers, lb. . . . .	173,200
Cylinders (simple), inches. . . . .	22 × 28
Diameter of drivers, inches. . . . .	56
Fire-box heating surface, square feet. . . . .	166·4
Heating surface in tubes (water side), square feet . . . . .	2,677·27
Total heating surface (based on water side of tubes), square feet . . . . .	2,843·67
Total heating surface (based on fire side of tubes), square feet. . . . .	2,482·26
Grate area, square feet . . . . .	49·2
Boiler pressure, lb. . . . .	205
Valves . . . . .	Richardson balanced
Link motion . . . . .	Stephenson
Fire-box, type . . . . .	Belpaire
Number of tubes . . . . .	373
Outside diameter of tubes, inches . . . . .	2
Length of tubes, inches. . . . .	164·5

**Simple consolidation locomotive Lake Shore & Michigan Southern Railway, No. 734.**

The second locomotive tested was built at the Brooks Works of the American Locomotive Company, and was submitted for test by the Lake Shore & Michigan Southern Railway. It was of the consolidation (2-8-0) type, belonged to class B-1 of the railroad company's classification, and was designated as No. 734. This locomotive and the Pennsylvania consolidation (No. 1499), already described, were the only two simple locomotives tested. They were practically identical in their dimensions, excepting as to the size of their grates. While the fire-box of the Pennsylvania locomotive extended out over the wheels, that of this locomotive was confined in width to the space between the wheels, the area of the grate being but 0·69 of that of the locomotive already described.

During the tests of this locomotive, the lowest boiler pressure was 192·8 pounds and the highest 204 pounds. Moisture of the steam in the dome did not exceed 1·6 per cent, and it was regarded as somewhat significant that this quality was apparently not affected by changes in the rate of evaporation. The equivalent evaporation per foot of heating surface ranged from 4·38 to 12·05 pounds per hour, the maximum boiler horse-power delivered being 887·5. Coal was fired at rates varying from 1,109 pounds to 4,695 pounds per hour, and the equivalent evaporation per pound of dry coal was between the limits of 10·7 pounds and 6·5 pounds. The greatest power and the best cylinder performance were obtained from a cut-off of 27 per cent and under a speed of 160 revolutions. Under these conditions, 1,054 indicated horse-power were developed upon a consumption of but 23·92 pounds of steam per indicated horse-power.

**Table II.**  
  
**Lake Shore & Michigan Southern locomotive No. 734.**  
*Built by Brooks Locomotive Works, Dunkirk, N. Y., 1900.*

**SUMMARY OF DATA.**

Number of test.	RUNNING CONDITIONS.			BOILER PERFORMANCE.					POWER.			WATER AND FUEL CONSUMPTION.			
	Revolutions per minute.	Miles per hour.	Cut-off percent stroke.	Throttle opening.	Equivalent evaporation, in pounds per hour.	Equivalent evaporation per square foot heating surface in pounds.	Boiler horse power.	Pounds of dry coal per hour.	Equivalent evaporation per pound of coal.	Indicated horse power.	Machine friction horse power.	Dynamometer pull, in pounds.	Steam I. H. P. per hour, in pounds.	Coal per I. H. P. per hour, in pounds.	Coal per D. H. P. per hour, in pounds.
I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI
201	40.3	7.6	19.1	Full.	11,122	4.38	322	1,109	10.0	299	67	11,531	29.56	3.53	4.55
202	40.5	7.6	30.7	—	15,162	5.97	439	1,412	10.7	434	33	19,860	27.78	3.10	3.36
203	40.1	7.5	41.3	—	18,599	7.32	539	2,027	9.2	550	59	24,522	27.31	3.55	3.98
204	80.0	15.0	43.9	—	28,500	11.21	826	4,468	6.3	901	84	20,444	26.11	4.88	5.39
205	80.5	15.1	47.3	—	16,864	6.64	489	1,781	9.5	527	64	11,515	25.89	3.28	3.73
206	80.1	15.0	30.7	—	23,540	9.28	683	2,729	8.6	783	51	18,288	24.55	3.41	3.65
208	80.0	15.0	40.7	—	29,453	11.59	854	4,152	7.1	962	68	22,371	24.93	4.22	4.54
209	159.3	29.9	21.1	—	26,780	10.54	776	3,435	7.7	866	80	9,861	25.11	3.86	4.25
210	159.9	30.0	23.3	—	28,713	11.30	832	4,096	7.0	954	103	10,642	24.67	4.22	4.72
211	160.0	30.0	29.0	—	31,361	12.34	909	5,061	6.2	995	134	10,755	26.04	5.02	5.80
212	160.3	30.0	27.4	—	30,620	12.05	887	4,695	6.5	1,054	157	11,188	23.92	4.38	5.16
213	160.4	30.1	39.8	Partial.	29,710	11.69	861	4,505	6.6	887	85	9,998	27.64	5.01	5.54
214	39.6	7.4	19.4	Full.	...	...	...	...	...	306	54	12,725	...	...	...
215	80.1	15.0	19.7	—	...	...	...	...	...	569	94	11,847	...	...	...
216	79.5	14.9	40.1	—	...	...	...	...	...	995	81	22,001	...	...	...
217	159.2	29.8	38.5	Partial.	29,190	11.49	846	3,975	7.3	799	40	9,540	30.11	4.91	5.17
218	160.1	30.0	39.0	—	29,352	11.55	851	4,509	6.5	865	22	10,538	28.01	5.14	5.28
219	158.8	29.8	30.9	—	28,712	11.29	832	4,079	7.0	923	86	10,546	25.53	4.34	4.78
220	160.0	30.0	24.6	—	28,280	11.13	820	3,950	7.2	942	135	10,096	24.67	4.12	4.81
221	118.9	22.3	35.7	Full.	...	...	...	...	...	1,098	141	16,104	...	...	...
222	119.4	22.4	37.5	—	...	...	...	...	...	1,098	98	16,744	...	...	...

The maximum draw-bar pull which was sustained for any test was 24,522 pounds. Greater traction was not attempted because of the imperfect action of the friction brakes of the testing plant, arising from variation in the pressure of the water supply. The maximum dynamometer horse-power was 897, and the coal consumption per dynamometer horse-power was as low as 3.36 pounds and for no test greater than 5.54 pounds. The minimum steam consumption per dynamometer horse-power was 26.26 pounds. The machine efficiency of this locomotive was remarkably high for a freight locomotive having four coupled axles, being in some cases in excess of 90 per cent, while that of locomotive No. 1499 never exceeded 85 per cent. This result was attributed to the fact that, in anticipation of the tests, locomotive No. 734 had been subjected to a long period of preliminary running upon the road. The lubrication of this engine, also, was effected by means of oil, while that of the Pennsylvania engine involved the use of grease. A summary of the data from all the tests with this locomotive is set forth in table II.

*Principal dimensions of locomotive No. 734.*

Total weight, lb. . . . .	181,300
Weight on drivers, lb. . . . .	162,600
Cylinders (simple), inches . . . . .	21 × 30
Diameter of drivers, inches . . . . .	63
Fire box heating surface, square feet . . . . .	218.92
Heating surface in tubes (water side), square feet . . . . .	2,638.97
Total heating surface (based on water side of tubes), square feet . . . . .	2,857.89
Total heating surface (based on fire side of tubes), square feet . . . . .	2,541.22
Grate area, square feet . . . . .	33.76
Boiler pressure, lb. . . . .	200
Valves . . . . .	Allen-Richardson
Link motion . . . . .	Stephenson
Fire-box, type. . . . .	Narrow, on top of frames
Number of tubes . . . . .	338
Outside diameter of tubes, inches . . . . .	2
Length of tubes, inches . . . . .	178.94

**Compound consolidation locomotive Michigan Central Railroad, No. 585.**

The third engine tested was built at the Schenectady Works of the American Locomotive Company and was submitted for test by the Michigan Central Railroad. It was of the consolidation (2-8-0) type, belonged to class W of the railroad company's classification, and was designated as No. 585. This locomotive was a two-cylinder cross-compound. It was a true receiver engine, the volume between the cylinders being sufficiently large to prevent undue fluctuation in pressure during such portions of the revolution as are represented by the difference in time which marks the valve action upon the two sides of the engine. Its boiler was somewhat larger than that of the simple locomotives already described and was designed for a higher pressure. Its principal dimensions are given on page 1790.

The lowest boiler pressure for any test made upon this locomotive was 205.8 pounds. The evaporation per hour was between the limits of 9,475 pounds and 23,311 pounds, the maximum limit representing the development of 799 boiler horse-power. The evaporation per square foot

**Table III.**  
**Michigan Central locomotive No. 585.**  
*Built by the American Locomotive Co., Schenectady, N. Y., 1902.*

**SUMMARY OF DATA.**

Number of test.	RUNNING CONDITIONS.				BOILER PERFORMANCE.					POWER.			WATER AND FUEL CONSUMPTION.		
	Revolutions per minute.	Miles per hour.	Cut-off per cent stroke, H. P. C.	Throttle opening.	Equivalent evaporation, in pounds per hour.	Equivalent evaporation per square foot heating surface per hour, in pounds.	Boiler horse power.	Pounds of dry coal per hour.	Equivalent evaporation per pound of dry coal.	Indicated horse power.	Machine friction horse power.	Dynamometer pull, in pounds.	Steam per I. H. P. per hour, in pounds.	Coal per I. H. P. per hour, in pounds.	Coal per D. H. P. per hour, in pounds.
I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI
301	40.0	7.5	43.1	Full.	11,180	3.97	324	1,027	10.89	442	31	20,605	20.20	2.22	2.38
302	40.0	7.5	45.3	—	11,966	4.25	347	1,013	11.82	477	35	22,449	20.09	2.03	2.19
303	40.0	7.5	48.6	—	12,884	4.57	373	1,073	12.01	512	30	24,105	20.27	2.01	2.14
305	80.0	15.0	45.7	—	20,205	7.17	586	1,770	11.41	841	67	19,393	19.54	2.05	2.23
306	80.2	15.0	42.2	—	18,178	6.45	527	1,683	10.80	735	59	16,879	20.15	2.23	2.42
308	80.0	15.0	52.8	—	22,476	7.97	651	2,087	10.77	932	61	21,815	19.69	2.19	2.34
309	80.0	15.0	57.5	—	25,501	9.05	739	2,559	9.97	1,041	61	24,539	20.03	2.41	2.56
311	117.9	22.1	50.6	—	...	...	...	...	...	998	97	15,297	...	...	...
312	160.0	30.0	49.6	—	25,075	8.89	727	2,687	9.24	890	160	9,138	23.18	2.96	3.61
313	160.0	30.0	50.7	—	27,576	9.78	799	2,767	9.97	992	168	10,308	22.80	2.74	3.30
316	160.0	30.0	64.1	—	29,700	10.53	861	3,876	7.66	1,001	142	10,762	24.43	3.82	4.44
317	160.0	30.0	51.5	Partial.	24,538	8.70	711	2,444	10.04	910	183	9,102	21.98	2.62	3.28
318	160.0	30.0	60.3	—	26,864	9.53	779	2,738	9.81	938	176	9,530	23.56	2.87	3.54
319	160.0	30.0	66.0	—	27,370	9.71	793	2,638	10.38	934	196	9,236	24.14	2.79	3.52

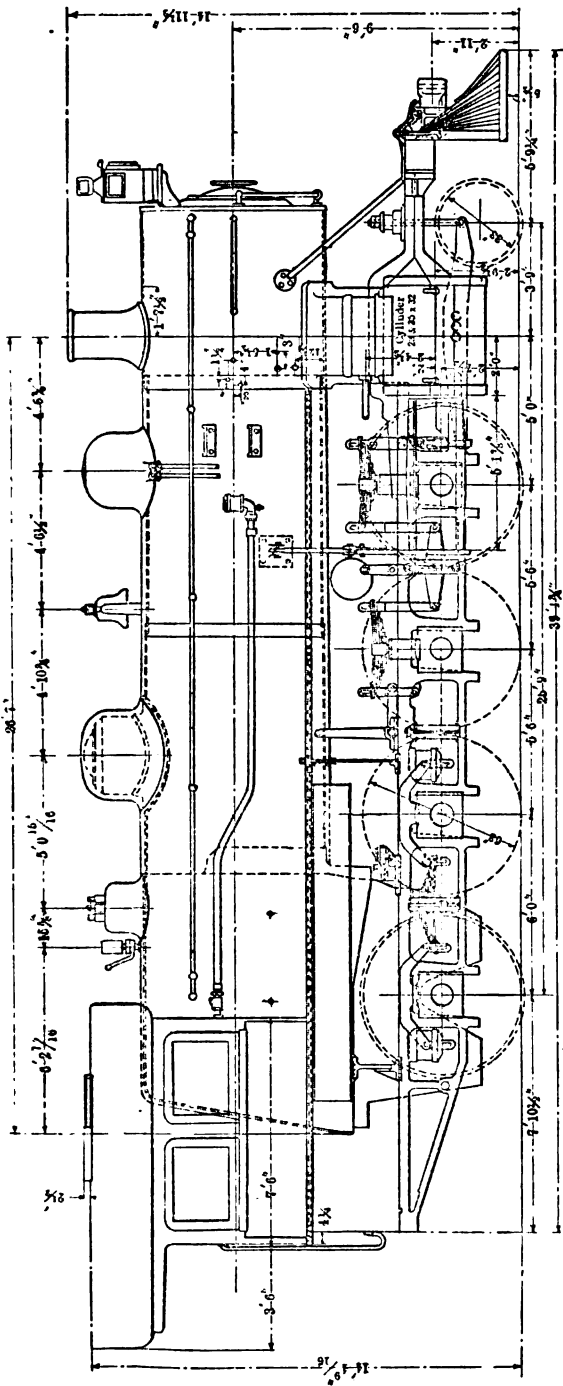


Fig. 3. — Locomotive No. 585, Michigan Central Railroad.

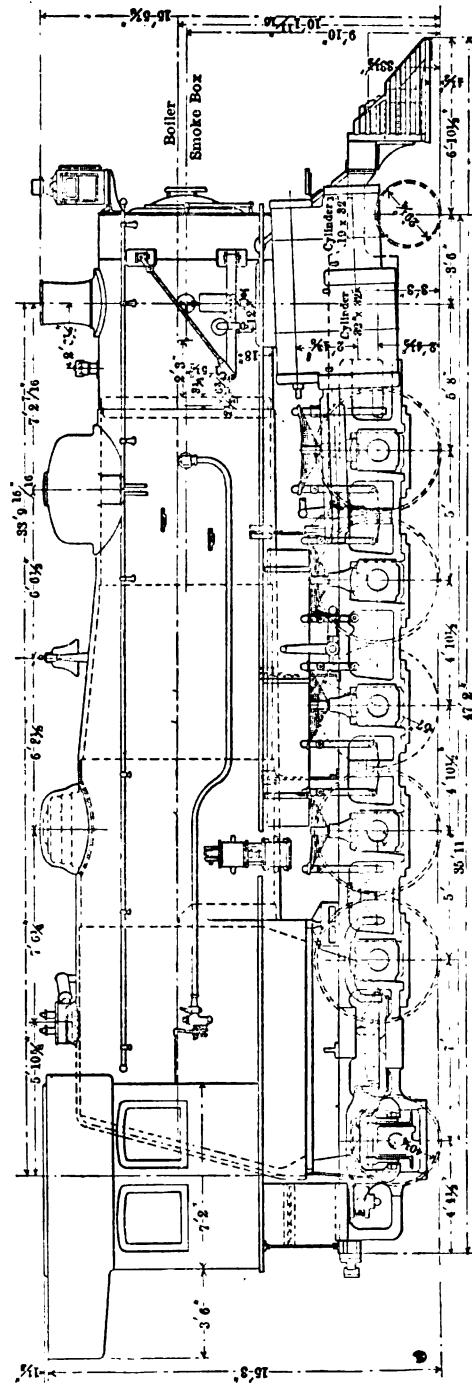


Fig. 4. — Locomotive No. 929, Atchison, Topeka & Santa Fe Railway.

of heating surface ranged from 3.97 to 9.78 pounds per hour. Coal was fired at rates per hour which were between the limits of 1,013 pounds and 2,767 pounds, and the evaporation per pound of dry coal was between the limits of 12.01 and 9.24 pounds. This locomotive developed a maximum of 1,041 indicated horse-power. Its best cylinder performance was obtained when the cut-off in the high-pressure cylinder was 46 per cent of the stroke, and at a speed of 80 revolutions per minute (15 miles per hour). Under these conditions, the steam consumption reached the low limit of 19.54 pounds per indicated horse-power hour. Two tests were run for which the consumption was below 20 pounds and no test under a full throttle gave a consumption which was greater than 23.18 pounds.

The maximum dynamometer horse-power developed was 980 and the amount of dry coal consumed per dynamometer horse-power was as low as 2.14 pounds, and never greater than 3.61 pounds. Under most favourable conditions, its consumption of steam per dynamometer horse-power hour was but 21.06 pounds. Not only was the cylinder and boiler performance of this locomotive high, but its machine efficiency also was most satisfactory, values ranging between the limits of 79 and 94 per cent.

In the twenty-two working days during which this engine occupied the plant, fourteen tests were made. Twelve days were lost through the necessity for adjustments upon the plant, and but three days on account of the locomotive. It was driven to high power and under whatever conditions it was run, it gave no trouble and its efficiency was high. A summary of the data from all tests is set forth by table III.

*Principal dimensions of locomotive No. 585.*

Total weight, lb. . . . .	189,000
Weight on drivers, lb. . . . .	164,500
Cylinders (compound), inches . . . . .	23 and 35 × 32
Diameter of drivers, inches . . . . .	63
Fire-box heating surface, square feet . . . . .	165.69
Heating surface in tubes (water side), square feet . . . . .	3,015.34
Total heating surface (based on water side of tubes), square feet . . . . .	3,181.03
Total heating surface (based on fire side of tubes), square feet. . . . .	2,819.20
Grate area, square feet . . . . .	49.43
Boiler pressure, lb. . . . .	210
Valves, high pressure, piston; low pressure . . . . .	Allen-Richardson
Link motion . . . . .	Stephenson
Fire-box, type . . . . .	Radial stay, wide
Number of tubes . . . . .	363
Outside diameter of tubes, inches . . . . .	2
Length of tubes, inches . . . . .	190.38

**Compound Santa Fe type locomotive Atchison, Topeka & Santa Fe Railway, No. 929.**

The fourth locomotive tested was built by the Baldwin Locomotive Works and was submitted for test by the Atchison, Topeka & Santa Fe Railroad. It was of the "Santa Fe" (2-10-2) type, and belonged to class 900, according to the railroad company's classification. This locomotive was a four-cylinder tandem compound, having a boiler designed for a working pressure of 225 pounds. It was equipped with Stephenson's link-motion driving piston valves. With

respect to extent of heating surface, area of grate and weight on drivers, it exceeded all other locomotives tested. Its principal dimensions are given below.

During the tests of this locomotive, an accident deprived the plant of the use of some of its brakes, making it impossible to develop the full power of the locomotive at low speed, and as no tests were made at speeds above 80 revolutions per minute, the results do not serve to establish the maximum capacity of the boiler nor the full power of the cylinders. It was found that without provisions for absorbing the longitudinal vibrations, it was impracticable to run the locomotive on the plant at speeds much above 80 revolutions a minute. The average boiler pressure while under test was never less than 213 pounds nor greater than 218 pounds. The highest evaporation was at the rate of 31,877 pounds per hour, or the equivalent of 1,067 boiler horse-power. The evaporation per square foot of heating surface was between the limits of 3 pounds and 8.55 pounds per hour, the maximum rate being less than that of any other boiler tested. While the dome of this locomotive was low and the throttle very near the water line, yet so long as the rate of evaporation did not exceed 30,000 pounds per hour, the steam delivered was of high quality. The coal fired per hour ranged between 1,111 pounds and 4,299 pounds, and the evaporation per pound of coal varied between the limits of 8.56 pounds and 11.63 pounds. The lowest speed at which any test was run was 6.7 miles per hour and the highest was 13.6 miles per hour.

Notwithstanding the limiting conditions already referred to, this locomotive was driven to the development of 1,258 indicated horse-power. The best cylinder performance was obtained when running with a cut-off of 41 per cent and 80 revolutions, under which conditions the steam consumption per indicated horse-power hour was 20.98 pounds.

The machine efficiency ranged between 80 per cent and 90 per cent, values which may be accepted as high for a locomotive having five coupled axles. The maximum dynamometer horse-power delivered by the locomotive was 1,136. Its coal consumption per dynamometer horse-power was as low as 2.7 pounds and under no conditions exceeded 3.74 pounds. The lowest steam consumption per dynamometer horse-power was 23.68 pounds.

A summary of the data from the several tests run is presented as table IV.

*Principal dimensions of locomotive No. 929.*

Total weight, lb. . . . .	285,740
Weight on drivers, lb. . . . .	233,760
Cylinders (compound), inches . . . . .	19 and 32 × 32
Diameter of drivers, inches . . . . .	56.5
Fire-box heating surface, square feet . . . . .	216.36
Heating surface in tubes (water side), square feet . . . . .	4,601.00
Total heating surface (based on water side of tubes), square feet . . . . .	4,817.36
Total heating surface (based on fire side of tubes), square feet . . . . .	4,306.13
Grate area, square feet . . . . .	53.41
Boiler pressure, lb. . . . .	225
Valves . . . . .	Piston
Link motion . . . . .	Stephenson
Fire-box, type . . . . .	Radial stay
Number of tubes . . . . .	393
Outside diameter of tubes, inches . . . . .	2.25
Length of tubes, inches . . . . .	238.5

**Table IV.**  
**Atchison, Topeka & Santa Fe Locomotive No. 929.**  
*Built by the Baldwin Locomotive Works, Philadelphia, Pa., 1903.*

**SUMMARY OF DATA.**

Number of test.	RUNNING CONDITIONS.				BOILER PERFORMANCE.						POWER.			WATER AND FUEL CONSUMPTION.		
	Revolutions per minute.	Miles per hour.	Cut-off percent of stroke. H. P. C.	Throttle opening.	Equivalent evaporation, in pounds per hour.	Equivalent evaporation, per square foot of heating surface per hour, in pounds.	Boiler horse power.	Pounds of dry coal per hour.	Equivalent evaporation per pound of dry coal.	Indicated horse power.	Machine friction horse power.	Dynamometer pull, in pounds.		Steam per I. H. P. per hour, in pounds.	Coal per I. H. P. per hour, in pounds.	Coal per D. H. P. per hour, in pounds.
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI
401	40.0	6.7	26.6	Full.	12,926	3.00	375	1,111	11.63	392	57	18,680		26.47	2.73	3.20
402	40.0	6.7	33.9	—	15,705	3.65	455	1,465	10.72	511	67	24,784		24.80	2.78	3.20
403	40.0	6.7	40.8	—	18,273	4.24	530	1,751	10.43	634	76	31,131		23.38	2.69	3.06
405	80.0	13.4	28.8	—	18,414	4.28	534	1,666	11.05	631	122	14,224		23.67	2.57	3.19
407	80.0	13.4	41.4	—	27,901	6.48	809	2,651	10.52	1,089	124	26,929		20.98	2.39	2.70
408	81.3	13.6	51.4	—	36,813	8.55	1,067	4,299	8.56	1,258	120	31,240		24.04	3.37	3.74
410	60.0	10.1	26.1	—	16,350	3.80	474	1,437	11.38	511	101	15,285		25.80	2.73	3.39
411	60.0	10.1	33.7	—	20,195	4.69	585	1,935	10.44	705	107	22,279		23.22	2.68	3.16
412	60.6	10.2	41.9	—	23,814	5.53	690	2,381	10.00	889	101	29,005		21.84	2.63	2.96

**Compound Atlantic type locomotive Pennsylvania Railroad, No. 2512.**

The fifth locomotive tested was built from the designs of Messrs. de Glehn and du Bousquet, by the « Société alsacienne de constructions mécaniques », at Belfort, France, and had been purchased and imported for the tests by the Pennsylvania Railroad. It was of the *Atlantic* (4-4-2) type, and was known in the railroad company's classification as No. 2512. With the exception of a few unimportant modifications, this locomotive was the exact duplicate of a number of machines furnished by its builders to the Northern Railway of France. Separate valve gears served to drive each high and low pressure valve, and the action of one system of valves could be varied independently of the other. The engine was of a true receiver type, the receiver being of considerable capacity. It was the only locomotive tested having Serre tubes, and as in all cases, the fire side of the tubes was taken as the basis for all calculations, the deductions for this locomotive involving heating surface include the surface of the ribs of the tubes. The principal dimensions of the de Glehn compound are presented further on.

The boiler pressure during the progress of the tests on this locomotive, was between 206 and 220 pounds. The evaporation per hour was between the limits of 7,066 pounds and 20,184 pounds per hour, the maximum boiler horse-power being 696. The quality of the steam delivered was at all times high. Coal was fired at rates varying between 690 pounds and 3,038 pounds per hour, the evaporation per pound of dry coal ranging from 7.9 pounds to 12.19 pounds.

The lowest speed at which any test was run was 19 miles per hour, while the highest speed was 67 miles per hour. The highest indicated horse-power was 945. The least steam consumption per indicated horse-power per hour was 18.6 pounds, obtained at a speed of 80 revolutions per minute. The cards for this locomotive are smooth in outline, and show an excellent distribution of steam except that for some of the tests; the distribution of work between the cylinders was not properly equalized.

The locomotive, as a whole, operated on the plant with great steadiness. High draw-bar pulls were not obtained, because of a belief on the part of those in charge, that a passenger locomotive should be tested under such draw-bar stress as can be sustained at higher speeds, where the capacity of the boiler rather than the adhesion of its drivers controls the limit of power. The maximum draw-bar pull was but 8,615 pounds, but the maximum dynamometer horse-power was 843. The coal per dynamometer horse-power was as low as 2.19 pounds, and never higher than 5.48 pounds. The minimum steam consumption per dynamometer horse-power hour was 20.96 pounds. The machine efficiency was between the limits of 75 and 89 per cent. A summary of the data from all tests is presented as table V.

*Principal dimensions of locomotive No. 2512.*

Total weight, lb. . . . .	164,000
Weight on drivers, lb. . . . .	87,850
Cylinders (compound), inches . . . . .	14 $\frac{3}{16}$ and 23 $\frac{1}{16}$ $\times$ 25 $\frac{1}{4}$
Diameter of drivers, inches . . . . .	80
Fire-box heating surface, square feet . . . . .	177.28
Heating surface in tubes (water side), square feet . . . . .	1,468.87
Total heating surface (based on water side of tubes), square feet . . . . .	1,646.15
Total heating surface (based on fire side of tubes), square feet . . . . .	2,656.48

**Table V.**  
**Pennsylvania Railroad locomotive No. 2512.**  
*Built by the Société Alsacienne de Constructions Mécaniques, Belfort, France, 1904.*  
**SUMMARY OF DATA.**

Number of test.	RUNNING CONDITIONS.				BOILER PERFORMANCE.						POWER.			WATER AND FUEL CONSUMPTION.		
	Revolutions per minute.	Miles per hour.	Cut-off percent of stroke, H. P. C. L. P. C.	Throttle opening.	Equivalent evaporation in pounds per hour.	Equivalent evaporation per square foot heating surface per hour, in pounds.	Boiler horse power.	Pounds of dry coal per hour.	Equivalent evaporation per pound of dry coal.	Indicated horse power.	Machine friction horse power.	Dynamometer pull, in pounds.	Steam I. H. P. per hour, in pounds.	Coal per I. H. P. per hour, in pounds.	Coal per D. H. P. per hour, in pounds.	
	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	
I																
501	80.0	49.4	26.9 52.1	Full.	8,416	3.17	244	690	12.19	310	33	5,443	21.20	2.09	2.34	
502	80.0	49.4	39.1 60.0	—	11,580	4.36	336	1,005	11.53	496	56	8,615	18.60	1.94	2.19	
505	160.0	38.3	25.2 52.3	—	13,089	4.93	379	1,157	11.31	524	81	4,343	19.95	2.12	2.52	
506	160.0	38.3	27.3 52.7	—	13,810	5.20	400	1,259	10.97	524	71	4,448	21.15	2.31	2.67	
507	160.0	38.3	38.4 60.1	—	20,091	7.56	582	2,247	8.94	809	109	5,976	19.60	2.69	3.57	
508	160.0	38.3	49.7 69.8	—	23,999	9.04	696	3,038	7.90	945	102	8,262	20.67	3.14	3.52	
510	240.0	57.4	27.7 50.0	—	16,273	6.13	472	1,761	9.24	597	243	2,309	21.95	2.86	4.83	
511	240.0	57.4	29.8 57.2	—	18,933	7.13	549	2,395	7.90	653	92	3,664	22.69	3.52	4.10	
512	240.0	57.4	34.2 62.2	—	22,088	8.32	640	2,641	8.36	802	149	4,268	21.62	3.17	3.90	
513	280.0	67.0	29.2 57.9	—	23,453	8.83	680	2,897	8.10	682	172	2,857	27.05	4.10	5.48	

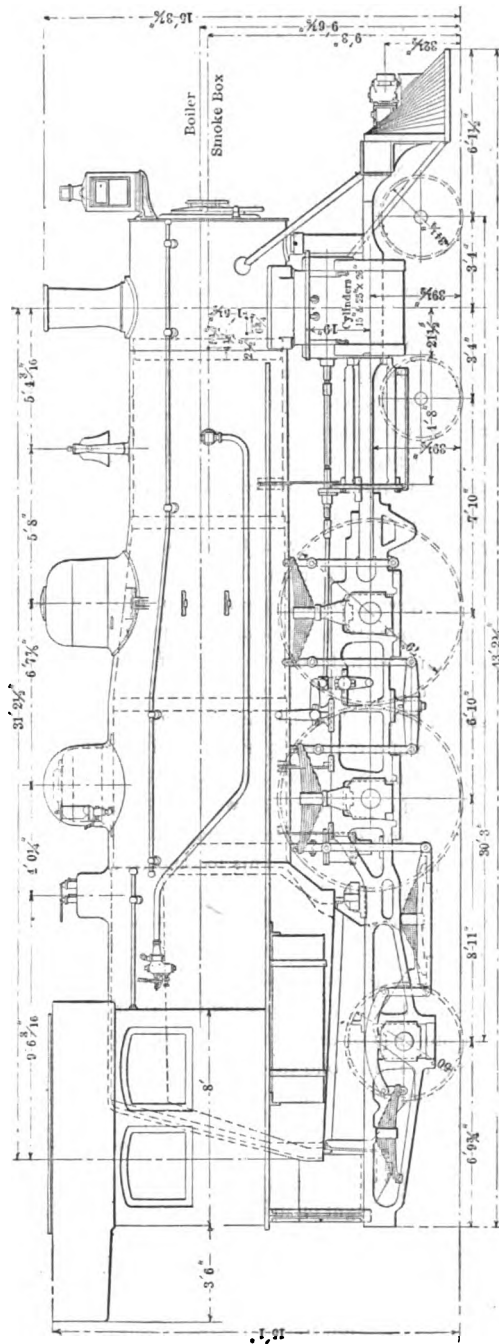


Fig. 6. — Locomotive No. 535, Atchison, Topeka & Santa Fe Railway.

Grate area, square feet . . . . .	33.39
Boiler pressure, lb. per square inch . . . . .	225
Valves . . . . . "D" slide, H. P. balanced; L. P., not balanced	
Valve motion . . . . .	Walschaerts
Fire-box, type . . . . .	Belpaire
Number of tubes (Serve). . . . .	139
Outside diameter of tubes, inches . . . . .	2 3/4
Length of tubes, inches . . . . .	176.14

**Compound Atlantic type locomotive Atchison, Topeka & Santa Fe Railroad, No. 535.**

The sixth locomotive tested was built by the Baldwin Locomotive Works, and was presented for test by the Atchison, Topeka & Santa Fe Railroad. It was a four-cylinder balanced compound of the *Atlantic* (4-4-2) type; it belonged to class 507 of the railroad system's classification, and was designated as No. 535. The two low-pressure cylinders were outside of the frames and the two high-pressure cylinders between them. All cylinders were connected with the front axle. In this locomotive, all cylinders were in line across the locomotive, so that all connecting rods were the same length. Steam was distributed to the high and low-pressure cylinders of each side by a single valve actuated by a single valve gear. The principal dimensions of this locomotive are given later on.

The lowest boiler pressure for any test was 211 pounds, and the highest was 222 pounds. The evaporation per hour was between the limits of 8,958 and 34,126 pounds, the latter rate agreeing with the development of 1,187 boiler horse-power. The evaporation per foot of heating surface per hour was between 3.67 and 14.11 pounds. Even at the latter rate, the quality of steam supplied to the throttle was good. The fact that this locomotive had the largest boiler volume of any passenger locomotive tested, may have contributed to this result. The rate at which coal was fired varied between 875 and 5,831 pounds per hour, and the evaporation per pound of dry coal was between 6.78 and 12.17 pounds.

The lowest speed at which any test was run was 19 miles per hour, and the highest was 66 miles per hour. This locomotive, under the conditions of a test, sustained a maximum of 1,622 indicated horse-power.

The maximum recorded draw-bar pull for any test was 12,815 pounds, and the maximum output of power at the draw-bar was 1,305 horse-power. The coal per dynamometer horse-power hour was as low as 2.65 pounds, and did not exceed 5.6 pounds. The machine efficiency ranged between 62 and 88 per cent. At high speeds, the frictional losses became very significant; in the case of this locomotive, the value during several tests was between 300 and 400 horse-power, and in one case was in excess of 500 horse-power. A summary of the data from all tests is presented as table VI.

*Principal dimensions of locomotive No. 535.*

Total weight, lb. . . . .	201,500
Weight on drivers, lb. . . . .	99,200
Cylinders (compound), inches . . . . .	15 and 25 × 26
Diameter of drivers, inches . . . . .	79
Fire-box heating surface, square feet . . . . .	220.3
Heating surface in tubes (water side), square feet . . . . .	3,016.71

**Table VI.**  
**Atchison, Topeka & Santa Fe locomotive No. 535.**  
*Built by the Baldwin Locomotive Works, Philadelphia, Pa., 1904.*

**SUMMARY OF DATA.**

Number of test.	RUNNING CONDITIONS.				BOILER PERFORMANCE.					POWER.			WATER AND FUEL CONSUMPTION.		
	Revolutions per minute.	Miles per hour.	Cut-off percent of stroke, H. P. C.	Throttle opening.	Equivalent evaporation, in pounds per hour.	Equivalent evaporation per square foot heating surface per hour, in pounds.	Boiler horse power.	Pounds of dry coal per hour.	Equivalent evaporation of coal.	Indicated horse power.	Ma- chine friction horse power.	Dynamometer pull, in pounds.	Steam per I. H. P. per hour, in pounds.	Coal per I. H. P. per hour, in pounds.	Coal per D. H. P. per hour, in pounds.
I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI
601	80.0	18.8	26.7	Full.	10,656	3.67	309	875	12.17	356	53	6,058	23.67	2.34	2.75
602	80.0	18.8	31.0	—	13,012	4.48	377	1,169	11.13	479	86	7,847	21.67	2.35	2.86
603	80.0	18.8	37.6	—	15,638	5.39	453	1,381	11.33	570	69	9,998	21.91	2.34	2.66
604	80.0	18.8	53.0	—	20,713	7.14	600	2,058	10.06	808	166	12,815	20.56	2.48	3.12
605	160.0	37.6	36.1	—	21,128	7.28	612	2,055	10.28	877	122	7,533	19.44	2.28	2.65
606	160.0	37.6	43.0	—	24,885	8.58	721	2,468	10.09	1,000	127	8,708	20.17	2.42	2.77
607	160.0	37.6	50.5	—	30,900	10.65	896	3,258	9.49	1,296	181	11,119	19.41	2.47	2.87
609	239.9	56.4	46.4	—	34,668	11.95	1,005	4,452	7.79	1,414	392	6,803	19.99	3.10	4.29
610	240.0	56.4	52.9	—	39,539	13.62	1,146	5,831	6.78	1,549	245	8,679	20.82	3.72	4.41
611	240.0	56.4	51.3	—	40,964	14.11	1,187	5,701	7.19	1,621	352	8,444	20.48	3.47	4.43
613	280.0	65.8	47.7	—	37,463	12.91	1,086	5,104	7.34	1,460	562	5,120	20.73	3.45	5.60

Total heating surface (based on water side of tubes), square feet . . .	3,237·01
Total heating surface (based on fire side of tubes), square feet . . .	2,902·05
Grate area, square feet . . . . .	48 36
Boiler pressure, lb. . . . .	220
Valves . . . . .	Piston
Link motion . . . . .	Stephenson
Fire-box, type . . . . .	Wagon top
Number of tubes . . . . .	273
Outside diameter of tubes, inches . . . . .	2·25
Length of tubes, inches . . . . .	225·14

**Compound Atlantic type locomotive Hannoversche Maschinenbau-Actien-Gesellschaft,  
No. 628.**

The seventh locomotive tested was built by the "Hannoversche Maschinenbau-Actien-Gesellschaft", and was presented for test by its builders. It was built for the Hanover directorate of the Royal Prussian Railway Administration, was of the *Atlantic* (4-4-2) type, was referred to as belonging to class S8 of the administration's classification, and was designated as No. 628. The locomotive is a four-cylinder balanced compound, all cylinders lying in the same cross-section of engine. The two high-pressure cylinders were between the frames, and the two low-pressure cylinders outside of the frames. The four cylinders are all connected with the forward axle. The valve motion was the Heusinger von Waldegg, otherwise known as the Walschaerts, modified by von Borries. The valve arrangement is such that each cylinder has a separate valve, but the valves of one high and one low-pressure cylinder are actuated from a single gear. The connections are such that by an ingenious arrangement of essential levers, the cut-off of the low pressure cylinder is later than that of the high-pressure cylinder, and the difference progresses as the cut-offs are lengthened. Another feature which distinguished this locomotive from others tested was the Pielock superheater with which it was equipped. This consisted of a chamber within the shell of the boiler, so arranged as to utilize a portion of the boiler tubes as superheating surface. The principal dimensions of the locomotive are given on page 1801.

In the process of conducting the tests, it was found difficult to make the locomotive steam. This appeared to be due to the inefficiency of the front-end, but may have been in part due to the fact that the coal used, while of high quality, was unlike that employed in Germany.

The rate of evaporation developed varied between the limits of 7,378 and 15,804 pounds per hour, the maximum rate corresponding with 11·9 pounds per foot of heating surface per hour. The quality of steam in the dome before passing to the superheater, was at all times exceptionally high, the moisture never exceeding 0·51 of one per cent. The degree of superheat in the steam after leaving the superheater and just before entering the dry-pipe, varied between the limits of 161 and 192° Fahr. The amount of superheating did not appear to be materially affected by different rates of evaporation. The consumption of superheated steam reached the low limit of 16·6 pounds per horse-power hour, which is equivalent to 17·82 pounds of saturated steam, a value far below that obtained from any other engine tested. The highest efficiency obtained at the draw-bar was that represented by a consumption of 2·52 pounds of coal and of 18·74 pounds of superheated steam per dynamometer horse-power per hour. A summary of all the tests run is presented as table VII.

**Table VII.**

**Hanover locomotive No. 628.**

*Built by the Hannoversche Maschinenbau-Actien-Gesellschaft, Linden vor Hannover, Germany 1904.*

**SUMMARY OF DATA.**

Number of test.	RUNNING CONDITIONS.				BOILER PERFORMANCE.					POWER.			WATER AND FUEL CONSUMPTION.		
	Revo- lutions per minute.	Miles per hour.	Cut-off percent of stroke, H. P. C.	Throttle opening.	Equivalent eva- poration, in pounds per hour.	Equivalent evaporation per square foot heating surface in pounds. per hour.	Boiler horse power.	Pounds of dry coal per hour.	Equivalent evaporation per pound of dry coal.	Indi- cated horse power.	Ma- chine friction horse power.	Dynamo- meter pull, in pounds.	Steam per I. H. P. per hour, in pounds.	Coal per I. H. P. per hour, in pounds.	Coal per D. H. P. per hour, in pounds.
	I	II	III	IV	V	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI
701	80.0	18.6	35.2	Full.	9,560	5.45	277	997	9.57	376	22	7,136	18.09	2.44	2.60
702	80.0	18.6	44.9	—	12,000	6.85	348	1,206	9.95	480	34	9,016	17.82	2.34	2.52
705	160.0	37.1	37.6	—	14,720	8.40	427	1,521	9.68	623	73	5,552	16.81	2.27	2.57
706	160.1	37.1	43.2	—	16,696	9.52	484	1,832	9.11	729	83	6,516	16.60	2.38	2.69
707	160.0	37.1	47.8	—	19,789	11.29	574	2,679	7.39	814	59	7,622	17.86	3.15	3.40
708	160.0	37.1	47.4	—	19,725	11.25	572	2,653	7.49	801	139	6,690	18.16	3.21	3.88
709	240.0	55.7	35.3	—	14,620	8.34	424	1,592	9.18	631	93	3,624	16.67	2.38	2.80
710	239.4	55.6	38.8	—	16,670	9.51	483	2,165	7.70	710	87	4,203	17.36	2.96	3.37
711	240.0	55.7	46.4	—	20,834	11.88	601	3,523	5.91	816	172	4,339	18.80	4.19	5.31
712	280.3	65.0	35.8	—	19,913	11.36	577	2,525	7.89	688	95	3,422	21.29	3.53	4.09

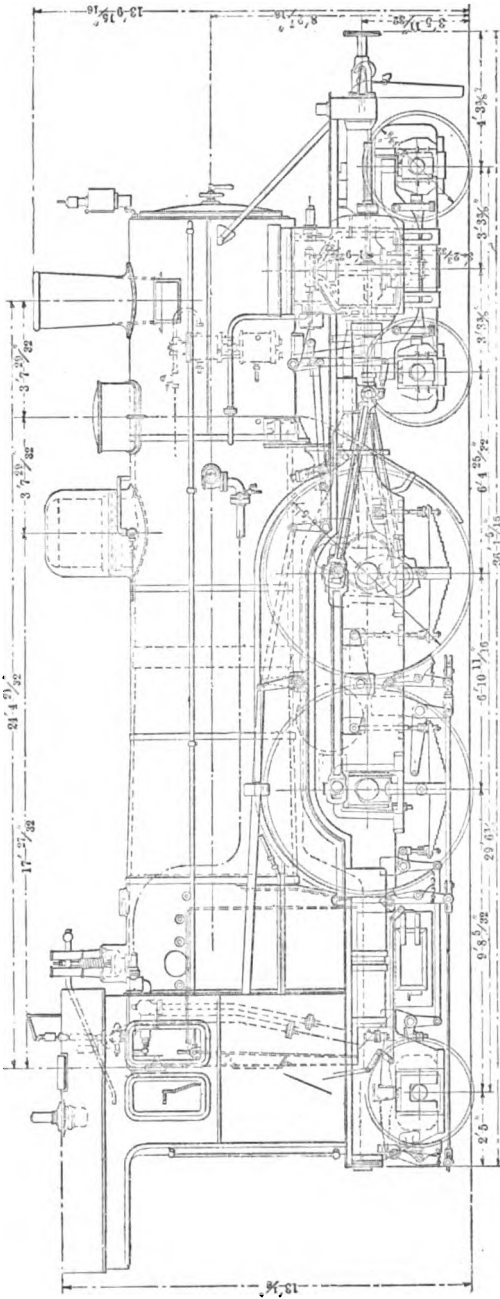


Fig. 7. — Locomotive No. 623, Hannoversche Maschinenbau-Actien-Gesellschaft.

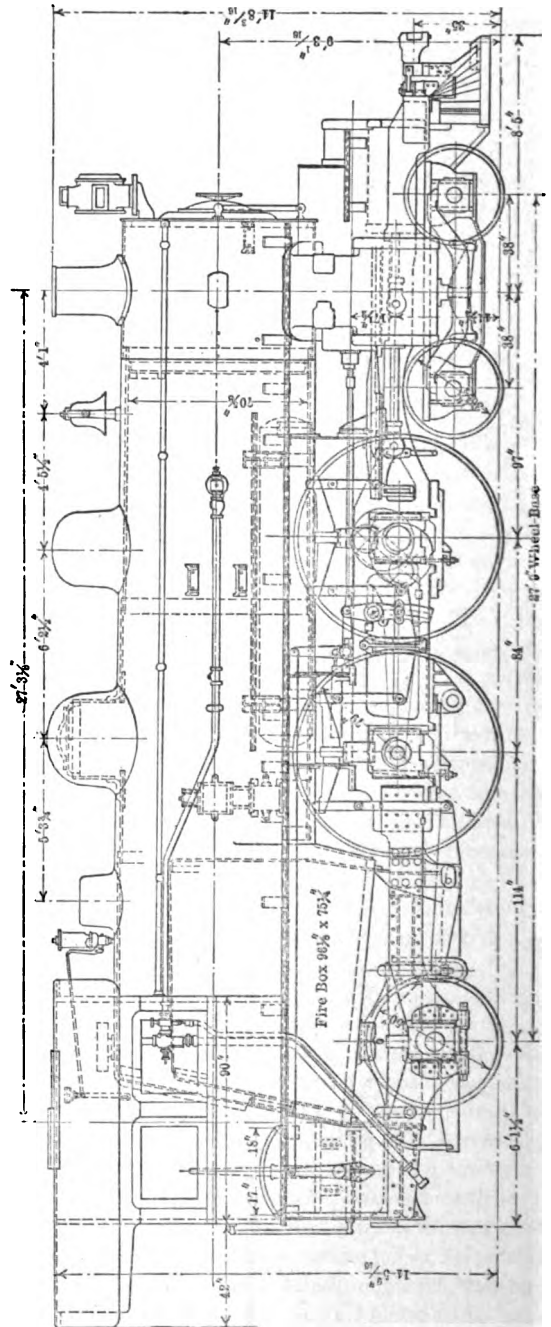


Fig. 8. — Locomotive No. 3000, New York Central & Hudson River Railroad.

*Principal dimensions of locomotive No. 628.*

Total weight, lb. . . . .	133,350
Weight on drivers, lb. . . . .	65,350
Cylinders (compound), inches . . . . .	14 $\frac{5}{32}$ and 22 $\times$ 23 $\frac{5}{8}$
Diameter of drivers, inches . . . . .	78
Fire-box heating surface, square feet . . . . .	105.59
Heating surface in tubes (water side), not including superheater, square feet . . . . .	1,511.94
Heating surface of superheater (fire side), square feet . . . . .	283.79
Total heating surface (based on water side of tubes), including superheater, square feet . . . . .	1,932.16
Total heating surface (based on fire side of tubes), including superheater, square feet . . . . .	1,753.15
Grate area, square feet . . . . .	29.06
Boiler pressure, lb. per square inch . . . . .	200
Valves . . . . .	High pressure, piston; low pressure, Allen balanced
Valve motion . . . . .	von Borries simplified Heusinger von Waldegg
Fire-box, type . . . . .	Wide
Number of tubes in boiler . . . . .	241
Number of tubes in superheater. . . . .	241
Outside diameter of tubes, inches . . . . .	2
Length of tubes (not including superheater), inches . . . . .	143.78
Length of tubes in superheater, inches. . . . .	29.92

**Compound Atlantic type locomotive New York Central & Hudson River Railroad, No. 3000.**

The eighth and last locomotive tested at St. Louis was built at the Schenectady Works of the American Locomotive Company, and was presented for test by the New York Central & Hudson River Railroad. It was of the *Atlantic* (4-4-2) type, belonged to class I<sub>4</sub> of the Company's classification, and was designated as No. 3000. It was a four-cylinder balanced compound and, in recognition of its designer, was commonly referred to as a "Cole balanced compound". The locomotive had two high-pressure cylinders between the frames, a little forward of the smoke-box, and arranged to drive the forward axle, the cranks of which were set quartering, and two low-pressure cylinders outside the frames driving the second axle. The balancing feature was secured by having each outside crank set at 180° with its adjacent inside crank. The distribution of steam to each high-pressure cylinder and to its corresponding low-pressure cylinder, was accomplished by means of a single valve driven by a single gear. The principal dimensions of this locomotive are given on page 1803.

This locomotive was on the plant twelve days, during which eleven formal tests were run, the last at a speed of 320 revolutions per minute or 75 miles per hour. No other locomotive on the plant was run continuously at a speed as high as this. The effect of the system of balancing set forth in this engine, was proved to be most satisfactory, the engine running with unusual steadiness upon the plant, even when the speed was high.

The lowest steam pressure for any test was 209 pounds, while the highest was 222 pounds. The maximum pull developed at the draw-bar during any test was 12,780 pounds, this result having been obtained at a nominal speed of 160 revolutions per minute, and at a cut-off in the high-pressure cylinder of 55 per cent. The evaporation per hour reached the high maximum of 41,120 pounds, which rate corresponds to the development of 1,421 boiler horse-power. The

**Table VIII.**  
**New York Central locomotive No. 3000.**  
*Built by the American Locomotive Co., Schenectady, N. Y., 1904.*

**SUMMARY OF DATA.**

RUNNING CONDITIONS.				BOILER PERFORMANCE.						POWER.			WATER AND FUEL CONSUMPTION.		
Number of test.	Miles per hour.		Cut-off percent of stroke, H. P. C.	Throttle opening.	Equivalent evaporation, in pounds per hour.	Equivalent evaporation per square foot heating surface, in pounds, per hour.	Boiler horse power.	Pounds of dry coal per hour.	Equivalent evaporation per pound of coal.	Indicated power.	Machine friction horse power.	Dynamometer pull, in pounds.	Steam per I. H. P. per hour, in pounds.	Coal per I. H. P. per hour, in pounds.	Coal per D. H. P. per hour, in pounds.
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
801	79.8	18.7	36.0	Full.	15,036	5.01	436	1,287	11.7	567	179	7,781	20.78	2.17	3.17
802	80.0	18.8	45.9	—	18,703	6.23	542	1,749	10.7	714	108	12,121	20.47	2.34	2.75
805	160.0	37.5	36.3	—	24,040	8.01	697	2,357	10.2	967	72	8,940	19.60	2.34	2.53
806	160.0	37.5	43.7	—	31,142	10.38	903	3,413	10.0	1,253	76	11,766	19.95	2.44	2.60
807	160.0	37.5	57.1	—	39,872	13.29	1,156	4,880	8.2	1,490	212	12,780	21.57	3.23	3.77
809	240.0	56.3	32.2	—	29,960	9.99	868	3,024	9.9	1,143	179	6,422	21.05	2.60	3.08
811	240.0	56.3	46.6	—	44,765	14.92	1,297	5,802	7.7	1,630	160	9,796	22.18	3.52	3.90
812	240.0	56.3	53.7	—	49,025	16.34	1,421	6,694	7.3	1,641	166	9,831	24.14	4.04	4.49
813	280.1	65.7	32.2	—	33,055	11.02	958	3,475	9.5	1,192	223	5,530	22.27	2.87	3.53
814	280.0	65.7	38.2	—	37,721	12.57	1,093	3,889	9.7	1,369	180	6,788	22.19	2.80	3.23
815	320.0	75.0	41.0	—	38,973	12.99	1,130	4,928	7.9	1,336	290	5,224	23.51	3.64	4.65

maximum evaporation per foot of heating surface per hour was 16·34 pounds. No other boiler was driven to as high a maximum power, or to as high a capacity per unit of heating surface. The power developed in the cylinders reached a maximum at 1,641 horse-power, and under most favourable conditions, the steam consumption was as low as 19·6 pounds per indicated horse-power hour. The development of a horse-power hour at the draw-bar, was obtained in return for 2·53 pounds of coal, and never resulted in the consumption of more than 4·65 pounds. The minimum steam per dynamometer horse-power was 21·19 pounds per hour. A summary of all tests run is set forth by table VIII.

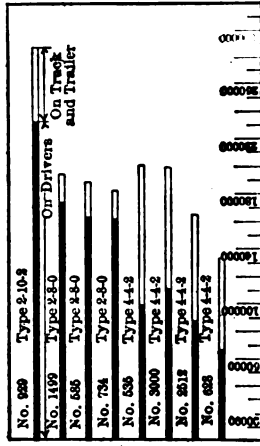
*Principal dimensions of locomotive No. 3000.*

Total weight, lb. . . . .	200,000
Weight on drivers, lb. . . . .	110,000
Cylinders (compound), inches . . . . .	15 1/2 and 26 × 26
Diameter of drivers, inches . . . . .	79
Fire-box heating surface, square feet . . . . .	151·69
Heating surface in tubes (water side), square feet . . . . .	3,255·27
Total heating surface (based on water side of tubes), square feet . . . . .	3,406·96
Total heating surface (based on fire side of tubes), square feet . . . . .	3,000·05
Grate area, square feet . . . . .	49 90
Boiler pressure, lb. . . . .	220
Valves . . . . .	Piston
Link motion . . . . .	Stephenson
Fire-box, type. . . . .	Wide
Number of tubes . . . . .	390
Outside diameter of tubes, inches . . . . .	2
Length of tubes, inches . . . . .	191·29

**COMPARISONS AND CONCLUSIONS.**

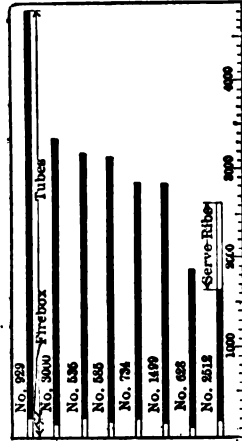
The purpose of the tests was chiefly to establish with accuracy the actual performance of certain typical locomotives, and incidentally to supply facts which would serve in comparing the performance of locomotive of different types. Such comparisons are made valuable by the fact that all tests were run with coal from the same mine, and that the several locomotives were subjected to substantially the same programme of tests. A comparison of some of the more important proportions of the several locomotives is presented by figures 9 to 12.

*Capacity.* — All locomotives which were upon the plant, with the exception of No. 929, were at some time during the progress of the tests, worked to the limit of their boiler capacity. The maximum capacity of each boiler measured in terms of equivalent evaporation per square foot of fire-heating surface per hour is shown by figure 13. The values shown are rates which were maintained for a period of at least one hour. It will be seen that the capacity ranged from 8 1/2 to more than 16 pounds of water per foot of heating surface, and that of all the boilers tested that of greatest capacity was the boiler of locomotive No. 3000, built at the Schenectady Works of the American Locomotive Company. This boiler maintained an equivalent evaporation of over 16 pounds of water per square foot of heating surface per hour, which is equivalent to the development of a boiler horse-power in return for 2·15 feet of surface in the



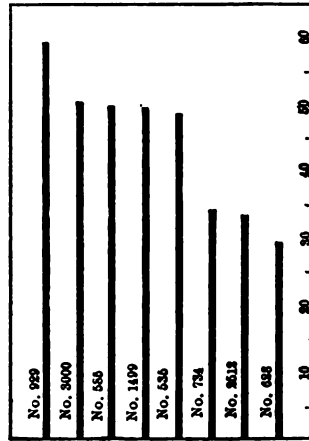
Weight in pounds.

Fig. 9. — Weight of locomotives.



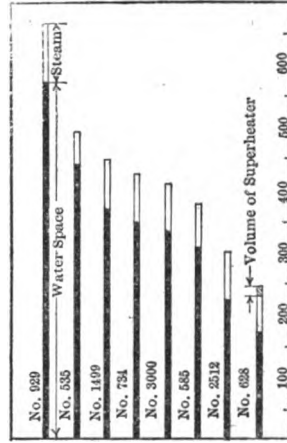
Total heating surface (inside fire-box, outside of tubes), sq. ft.

Fig. 10. — Heating surfaces.



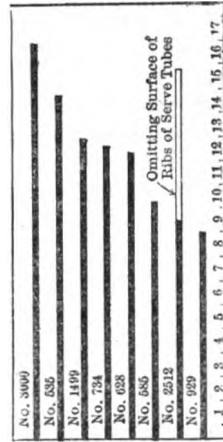
Grate area, square feet.

Fig. 11. — Grate areas.



Volume of boiler in cubic feet.

Fig. 12. — Boiler volumes.



Pounds of water per sq. ft. of heating surface per hour.

Fig. 13. — Maximum boiler capacities.

boiler. Not only was the capacity of this boiler greater than that of other boilers, but it exceeds the next higher by more than 2 pounds.

The capacity of locomotive No. 2512 which was fitted with Serve tubes, is represented as figured from a two-fold basis. The heavy line is its capacity when the heating surface is made to include the actual area of surface exposed to the heated gases; the heavy and light line together represent the capacity when the area of the ribs of the tubes are excluded, that is, assuming the boiler to have been supplied with plain tubes. While the values of figure 13 represent maximum performance, the record for each locomotive being based upon a single test, they indicate that little or no advantage is found in the use of Serve or ribbed tubes.

The boiler capacity of the several locomotives tested, as represented by all tests run, is shown graphically by figure 14.

*Evaporative Efficiency.* — The evaporation per pound of dry coal, in terms of coal burned, and also in terms of the rate of evaporation, is shown by figures 15 and 16. These diagrams show the degree to which efficiency diminishes as the rate of power developed is increased. When the power is low, the evaporation per pound of coal is between 10 and 12 pounds, whereas when the power developed is high, the evaporation declines to approximately two-thirds of these values. These results will be found to compare favourably with those obtained in good stationary practice, but such practice embraces only those conditions which in figures 15 and 16 are represented by the extreme left-hand portions of the curves. For example, the rate of evaporation in stationary practice does not often exceed 4 pounds of water per foot of heating surface hour. The fact that the boiler of a locomotive may be, and often is, pushed to three or four times this capacity constitutes one of the interesting characteristics of the locomotive service. The best evaporation seems to have been obtained from locomotives Nos. 585 and 3000, from the former at low power and from the latter at both high and low power. Both of these locomotives were built by the American Locomotive Company.

*Grate Areas.* — The tests do not definitely settle the relative advantage of large and small grates. They are, however, conclusive in proving that furnace losses arising from excess air are no greater with large grates properly fired than with smaller ones, a fact which is significant in view of a generally accepted opinion to the contrary. There is, on the other hand, some positive evidence in favour of the large grate. For example, it appears from figure 14 that locomotives Nos. 734 and 929, which had relatively small grates, were distinctly inferior in capacity to the locomotives having boilers with larger grates.

The data also contains a suggestion with reference to the relative value of fire-box heating surface, as compared with heating surface in tubes. Locomotives Nos. 585 and 3000 had much smaller fire-box heating surface than the others, notwithstanding which fact their capacity (fig. 14) is exceptionally high. The evidence, contrary to a common assumption, is to the effect that no special advantage is to be derived from large fire-box heating surface; that the tube-heating surface is effective in absorbing heat not taken up by the fire-box.

The copper fire-boxes, with which locomotives Nos. 2512 and 628 were fitted, appear to have given these locomotives no advantage over other locomotives either with respect to economy or efficiency.

*Furnace Temperature and Combustion.* — Evidences of imperfect combustion were looked for in the smoke-box gases, where the presence of 1 per cent of carbon monoxide (CO) implies the

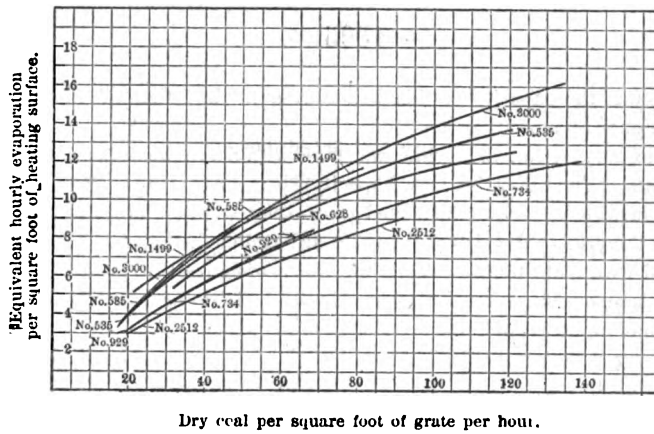


Fig. 14. — Boiler capacities.

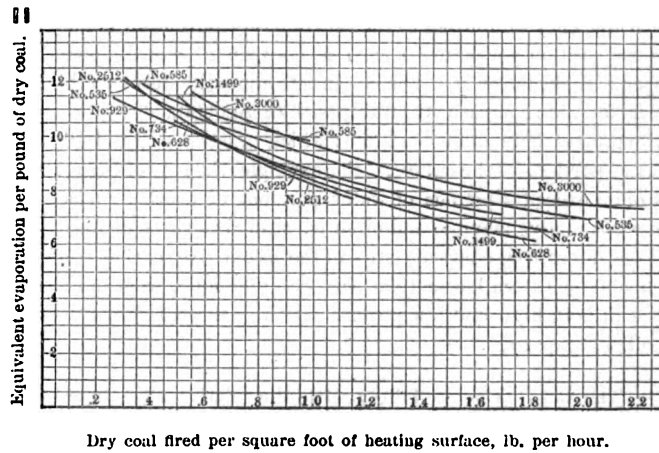


Fig. 15. — Boiler efficiencies referred to coal per square foot of heating surface.

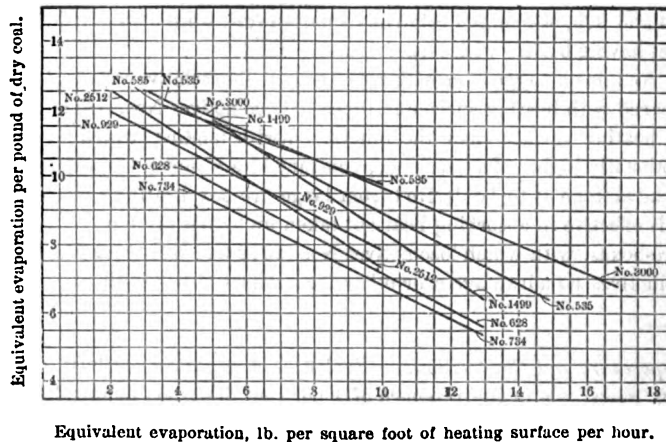


Fig. 16. — Equivalent evaporation.

loss of combustible gas equal in heating value to 4 per cent of the coal fired. In most cases, it was found that the amount of carbon monoxide in the smoke-box gases amounted to hardly more than a trace, being less than  $\frac{1}{2}$  of 1 per cent. It reached its maximum value in locomotives Nos. 1499 and 628 at approximately 4 per cent, an amount which represents a fuel loss of approximately 16 per cent. For three other locomotives, the maximum value was approximately 1 per cent, while for locomotives Nos. 3000 and 734 it never exceeded  $\frac{1}{2}$  of 1 per cent. These are maximum values. While the results show that the CO tends to increase somewhat with increased rates of combustion, the fact remains that for most tests, the amount present was very small, a conclusion which will be reassuring to those who have feared that the very high rates of combustion incident to locomotive service were necessarily attended by incomplete combustion. It is of interest to note, also, that the two locomotives showing the least evidence of incomplete combustion (Nos. 3000 and 734) were both built by the American Locomotive Company, the former at the Schenectady Works, and the latter at the Brooks Works. The maximum fuel lost through imperfect combustion for any test upon locomotive No. 3000, amounts to but 1.25 per cent.

The fire-box temperature was found to increase with the rate of combustion by an amount which evidently is affected by the characteristics of the locomotive. Basing a statement upon the observed data from all locomotives tested, it may be said that when combustion proceeds at the rate of 25 pounds of coal per foot of grate surface per hour, the fire-box temperature is between 1,400 and 2,100° Fahr. When the rate of combustion is increased to 125 pounds per hour, the fire-box temperature lies between the limits of 2,150 and 2,300° Fahr. For locomotive No. 3000, the minimum temperature in round numbers was 1,900° Fahr., and the maximum was 2,300° Fahr., a comparatively small change as a result of five-fold change in the rate of combustion. It is but reasonable to suppose that the fire-box temperature is a function of the fire-box surface as well as of the rate of combustion, but this is a matter which is not shown by the data, or if shown has not yet been developed from it. The data clearly indicates the influence of a brick arch on the fire-box temperature, the temperature generally being higher for those locomotives which were equipped with such an arch. All this justifies the statement that those conditions which promote the passage of heat from the fire to the heating surface of the fire-box, assist in reducing the temperature of the fire-box. There appears, also, to be some relation between fire-box temperature and the discharge of carbon monoxide (CO). Those locomotives which developed the highest fire-box temperature gave the lowest percentages of CO, while those locomotives which gave the lowest temperature were highest in the amount of CO discharged. Such a result is not unexpected, but since the amount of CO developed is in all cases small, it is of interest to note that the data permits a relation to be traced.

*Draft.* — Confirming results of previous experiments, the Pennsylvania tests show that an equation for draft in terms of the rate of combustion may be represented by a straight line. Such an equation takes the form of

$$D = c \times G$$

where D is the draft in inches of water, G the pounds of coal per foot of grate per hour, and c a constant depending upon the proportions of the locomotive.

The draft in the ash-pan for the several locomotives tested was such as to give the constant in the above equation values ranging from 0.002 to 0.018; that is, when 100 pounds of coal are being burned per foot of grate per hour, the draft in the ash-pan is between 0.2 and 1.8 inches

of water. Obviously, the draft in the ash-pan must depend upon the area of the air openings, and an analysis of the data shows that when these were such as to allow 0.14 square feet of opening for each foot of grate, further increase did not serve materially to diminish the draft required; also, that when the area of the inlet was less than 0.11 square feet per foot of grate, the draft necessary to supply air to the ash-pan increased rapidly. The conclusion is that the air opening should be between 0.11 and 0.14 of the area of the grate. When thus proportioned, the draft in the ash-pan may be found by giving  $c$  in the equation a value of not less than 0.002, nor more than 0.003.

The difference in the draft of the ash-pan and fire-box, depends upon the condition and thickness of the bed of coal and ash upon the grate. Within the limits of variation presented by the locomotive tests, it does not appear to be affected by the ratio of air openings in the grate to the total grate. The average difference of draft between the ash-pan and fire-box may be found by making the co-efficient  $c$  in the equation 0.011.

The draft absorbed by the tubes depends upon their size, number and length. Employing the equation to represent it, the co-efficient was least for locomotive No. 929, for which its value was 0.013; it was greatest for No. 3000, for which its value was 0.029. For three locomotives, it was between 0.016 and 0.018, and for three others it was between 0.021 and 0.025. Accepting 0.02 as a representative value, it may be said that the resistance of the tubes absorbs 1 inch of draft for each 50 pounds of coal burned per foot of grate per hour.

The difference in the draft between the two sides of the diaphragm demonstrates the influence of different front-end arrangements. It was greatest for locomotives Nos. 734, 535 and 3000, which had self-clearing front-ends. The absence of obstructions in the front-ends of the foreign locomotives (Nos. 2512 and 628), permitted them to sustain a given rate of combustion upon less draft than any of the other locomotives tested. The resistance of the diaphragm may be defined by use of the equation. For the self-clearing front ends (locomotives Nos. 734, 535 and 3000), the value of the co-efficient was from 0.020 to 0.021; for locomotives Nos. 585 and 929 it was 0.016 and 0.015, respectively; for locomotive No. 1499 it was but 0.005, and for the foreign engine which had no diaphragm, it was, of course, zero.

Table IX.

LOCOMOTIVE NUMBER.	COEFFICIENTS OF DRAFT.			
	Front of diaphragm.	Back of diaphragm.	Fire-box.	Ash-pan.
Freight 585 . . . .	0.058	0.042	0.017	0.002
— 1499 . . . .	0.049	0.044	0.027	0.018
— 734 . . . .	0.047	0.026	0.010	0.002
— 929 . . . .	0.044	0.029	0.016	0.007
Passenger 3000 . . . .	0.066	0.045	0.016	0.006
— 535 . . . .	0.058	0.038	0.017	0.005
— 2512 . . . .	...	0.038 (1)	0.013	0.002
— 628 . . . .	...	0.034 (1)	0.016	0.003

(1) This locomotive had no diaphragm in smoke box.

The actual draft values at several points in the flow of the air and gases for all of the locomotives tested, may be found by employing the co-efficients of table IX, in connection with the equation already given.

*The Quality of Steam* in the dome of the several locomotives tested was remarkably uniform, the moisture present being generally less than 1 1/2 per cent. The exceptions to this statement arise, it is believed, from foul boilers or imperfect water. The water used was chemically treated, and a certain amount of sodium sulphate and other salts found their way to the boilers, which, when concentrated, caused foaming. As it was not possible to blow out the boilers frequently, trouble from this source could not always be avoided.

*Indicated Power.* — The results show that the modern simple freight locomotive of the types tested, can be depended upon to develop continuously from 1,000 to 1,100 indicated horse-power, and that the modern compound passenger locomotive may develop under constant conditions of running, in excess of 1,600 horse-power. The maximum power for each locomotive tested is shown by table X.

**Table X.**

LOCOMOTIVE NUMBER.	MAXIMUM INDICATED HORSE POWER.	LOCOMOTIVE NUMBER.	MAXIMUM INDICATED HORSE POWER.
Freight 929 . . . .	1,258	Passenger 3000. . . .	1,641
— 734 . . . .	1,098	— 535. . . .	1,622
— 1499 . . . .	1,050	— 2512. . . .	945
— 585 . . . .	1,041	— 628. . . .	816

*Steam Consumption.* — Particularly significant is the high economy which attends the operation of the modern locomotive. The performance of the simple locomotives operating at all speeds and cut-offs commonly employed upon the road, falls between the limits of 23.4 and 28.3 pounds of steam per indicated horse-power hour. The compound locomotives, under all the various conditions of running to which they were subjected, gave an indicated horse-power hour in return for the consumption of from 18.6 to 27 pounds of steam, and with superheating, the minimum consumption was reduced to 16.6 pounds of superheated steam. Certain interesting facts concerning the performance of the simple locomotive are shown by table XI, and similar facts concerning the compound locomotives are shown by table XII.

**Table XI.**

SIMPLE FREIGHT LOCOMOTIVES.	149	734	Average.
Minimum water per indicated horse power-hour . . . .	23 43	23.92	23 67
Water per indicated horse power-hour, maximum load . . .	23 74	23 92	23.83
— — — — consumption .	28.33	29 56	28.97

**Table XII.**

COMPOUND LOCOMOTIVES.	Minimum water per indicated horse-power-hour.	Water per indicated horse-power-hour, maximum load.	Water per indicated horse-power-hour, maximum consumption.
585. . . . .	19·54	20·03	24·14
929. . . . .	20·98	24·04	26·47
2512. . . . .	18·60	20·67	27·05
535. . . . .	19·41	20·48	23·67
628 (1). . . . .	16·60	18·80	21·29
628 (2). . . . .	17·82	20·26	22·77
3000. . . . .	19·60	24·14	24·14
Average freight . . . . .	20·26	22·03	25·31
— passenger . . . . .	18·86	21·39	24·41

(1) Superheated steam.  
(2) Saturated steam, calculated from the quantity of superheated steam used.

The tables present the evidence by which the relative economy of simple and compound locomotives is to be judged. Incidentally, also, the values of table XII emphasize the all-around good work of the two-cylinder cross compound, No. 585, which was built at the Schenectady Works of the American Locomotive Company.

In general, the steam consumption of the simple engines decreased with increase of speed, while that of the compounds increased. These effects operate to reduce the relative advantage of the compounds as the speed is increased. The facts in the case touching this matter, may be seen by reference to table XIII. This table expresses the steam consumption of the several freight engines, assuming that of the two-cylinder compound (No. 585) to be unity. For example, at 40 revolutions per minute, for each pound of steam per horse-power hour consumed by No. 585, 1·23 pounds were consumed by the tandem compound (No. 929) and 1·38 pounds were consumed by the simple locomotive, No. 1499. At higher speeds, these differences are materially reduced. Comparing the performance of the compound, No. 585, with that of the simple locomotive, No. 734, the difference at 40 revolutions is 40 per cent, and at 160 revolutions but 7 per cent. By curves plotted from the values of all tests, it can be shown that at 200 revolutions, the consumption of these two machines would be identical, and it is conceivable that at speeds above this value, the simple engine would have the best of it. It is well to remember, however, that this comparison is based upon a very limited number of locomotives.

**Table XIII.**

FREIGHT LOCOMOTIVE NUMBER.	40 revolutions per minute.	80 revolutions per minute.	160 revolutions per minute.
585 . . . . .	1·00	1·00	1·00
929 . . . . .	1·23	1·15	...
1499 . . . . .	1·38	1·25	1·06
734 . . . . .	1·40	1·27	1·07

Comparing the performance of the compounds, as set forth in table XII, and as illustrated by table XIV, setting forth the relative performance of the four-cylinder balanced compounds, some estimate may be had concerning the value of certain elements of design which characterize the several machines.

Table XIV.

PASSENGER LOCOMOTIVE NUMBER.	80 revolutions per minute.	160 revolutions per minute.	240 revolutions per minute.	280 revolutions per minute.
2512 . . . . .	1.11	1.17	1.26	1.27
535 . . . . .	1.22	1.13	1.16	0.97
628 (1) . . . . .	1.00	1.00	1.00	1.00
628 (2) . . . . .	1.07	1.07	1.06	1.07
3000 . . . . .	1.15	1.17	1.28	1.04

(1) Superheated steam.  
(2) Saturated steam, calculated.

It will be seen that of the balanced compounds, the Hanover engine (No. 628) gave the best cylinder performance. Among the factors contributing to such a result, are the use of superheated steam, of separate valves for each of its four cylinders, a stiff valve gear which gave a high degree of precision to the motion of the valves, and of a gear so well designed as to provide for a high degree of refinement in the distribution of its steam. With all of these advantages, its performance under maximum load when reduced to a common basis for comparison, was but a quarter of a pound better than that of the cross-compound (No. 585). This fact, coupled with the fact that the engine could not fail to derive great advantage from its superheater, illustrates how little is to be gained through the use of highly refined valve gears.

The fact to which attention has already been called is further illustrated by the performance of the de Glehn compound, No. 2512, which is a true receiver engine, having separate valves and separate valve gears for each of its four cylinders, with control of the distribution in the low-pressure cylinders independent of that of the high-pressure cylinders. While for various reasons the tests of No. 2512 were more limited than was desired, and while the performance of the engine places it among the most efficient of all that were tested, the fact remains that the record presents but meager evidence to justify the complication which characterizes this design.

As compared with the foreign engines, the American balanced compounds, Nos. 3000 and 535, were equipped with simple forms of valves and gears. Both were non-receiver engines, and minimum and maximum portions of the indicated power which appeared as a stress in the draw-bar are given as table XV. If the values given are subtracted from unity, the result will be the fraction of the indicated power which is absorbed by machine friction.

As these values were obtained upon the testing plant, no account is made of atmospheric resistance, nor of that resistance which upon the road arises from the rolling load of truck and tender. The values given are less than the indicated power merely by that amount which is lost in transmission between the engine pistons and the tread of the drivers.

The results show that the frictional losses increase as the speed is increased. They vary in

different machines and under different conditions of running, from 6 to 38 per cent of the indicated horse-power, a range so great as to suggest the importance of a more elaborate analysis. Evidently, the matter of machine friction is closely related to that of lubrication. The record shows that where oil lubrication was used for rods and axles, it was by means of the customary American methods, except in the case of locomotives Nos. 628 and 2512, which had a lubricating pad held against the axle by springs in a manner common in European practice. Where grease was used, it was composed 29 per cent oil, 56 per cent soap, and 15 per cent water. This lubricant, shaped into a hard cake, was pressed against the axle journal by springs fixed in the cellars, a perforated plate between the axle and the cake of grease serving to preserve the latter from too rapid destruction. Grease in rod lubrication was carried in cups from which it was forced out upon the journal by means of a screw.

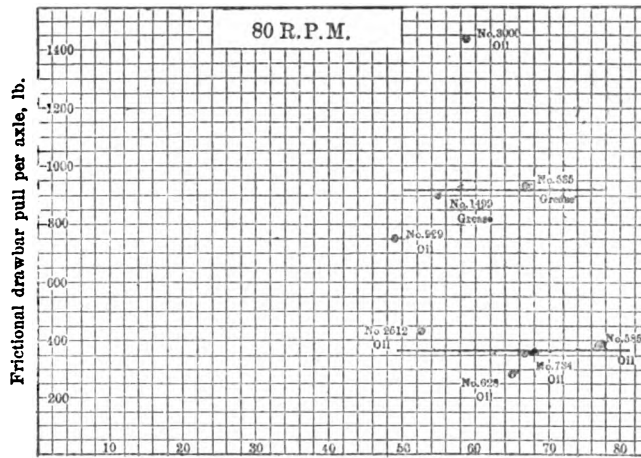
Table XV.

REVOLUTIONS.	Maximum.	Minimum.
40 . . . . .	0·941	0·767
80 . . . . .	0·941	0·795
160 . . . . .	0·939	0·729
240 . . . . .	0·902	0·723
280 . . . . .	0·868	0·615
320 . . . . .	0·783	0·783

The friction in terms of pounds draw-bar per driving axle, is shown graphically by figures 17, 18 and 19. The plotted points upon these diagrams are marked with the locomotive number and with the kind of lubricant used upon the driving axles. A study of the problem made it apparent that the friction of the driving axles was so large a factor in the total friction, as to obscure the effect of the rod lubrication, whether this were grease or oil. The horizontal lines drawn upon each diagram, are designed to show a representative value for each system of lubrication. The results obtained at a speed of 80 revolutions are not without contradiction, the evidence being that at this low speed the oil lubrication was in some cases imperfect. At higher speeds, the results group themselves very consistently. It appears that with oil lubrication, a stress at the draw-bar of approximately 500 pounds is required to overcome the friction of each coupled axle, while with grease the required force is from 800 to 1,100 pounds.

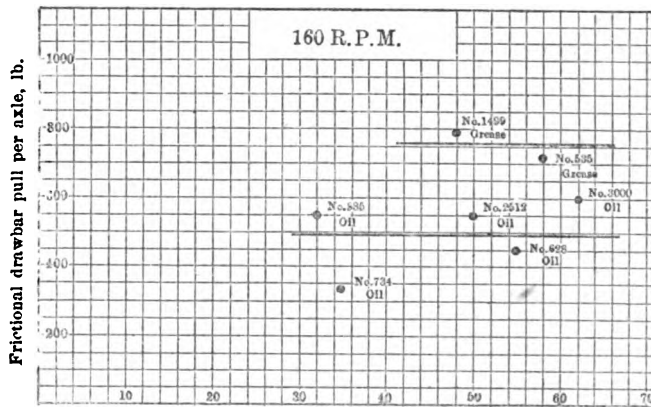
*Effect of the Counterbalancing.* — The counterbalancing of the passenger locomotives, all of which were of the balanced compound type, was investigated by observing the speed at which the disturbing forces arising from the action of the locomotive first affected the dynamometer, by measuring the transverse movement of the pilot with each revolution, and by estimating the variation in pressure between the drivers and their supporting wheels, by the effect produced upon a length of soft annealed wire of small diameter, which had been passed between them.

The lowest speed at which the disturbing forces of the engine first affected the dynamometer was as in table XVI.



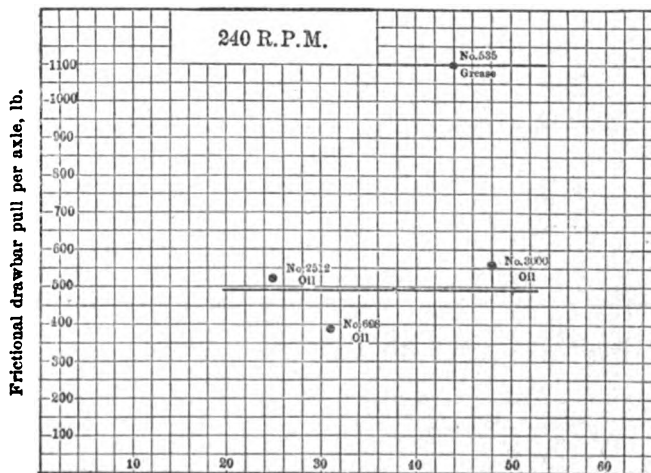
Ratio of maximum recorded drawbar pull to maximum tractive effort.

Fig. 17. — Machine friction.



Ratio of maximum recorded drawbar pull to maximum tractive effort.

Fig. 18. — Machine friction.



Ratio of maximum recorded drawbar pull to maximum tractive effort.

Fig. 19. — Machine friction.

**Table XVI.**

No. 2512 . . . . .	197 revolutions per minute.
No. 535. . . . .	180 — —
No. 628. . . . .	200 — —
No. 3000 . . . . .	320 — —

The transverse vibration of the pilot was determined by means of an automatic recording device, the values observed being afterwards reduced to equivalent values, which would have been registered had the marking point always been a fixed distance from the front axle. Maximum values thus obtained were as stated in table XVII.

**Table XVII.**

NUMBER OF LOCOMOTIVES.	MAXIMUM VIBRATION OF PILOT : INCHES.			
	At 160 revolutions per minute.	At 240 revolutions per minute.	At 280 revolutions per minute.	At 320 revolutions per minute.
2512. . . . .	...	0·277	0·296	...
535. . . . .	0·456	0·592	0·592	...
628. . . . .	0·093	0·233	0·465	...
3000. . . . .	0·235	0·120	0·110	0·110

The effectiveness of the vertical balancing of the several locomotives, was determined from wires which had been run between the driver and its supporting wheel. These in their original condition were of 0·06 inch diameter, and of a length somewhat greater than the circumference of the drivers. The wires which had passed under the drivers were carefully measured at 5-inch intervals to determine changes in thickness. Maximum variations during a single revolution of the drivers, thus determined, were as given in table XVIII.

**Table XVIII.**

NUMBER OF LOCOMOTIVES.	MAXIMUM VARIATIONS IN THICKNESS OF WIRE : INCHES.			
	At 160 revolutions per minute.	At 240 revolutions per minute.	At 280 revolutions per minute.	At 320 revolutions per minute.
2512. . . . .	...	0·014	0·012	...
535. . . . .	0·011	0·026	0·042	Driver left the wire.
628. . . . .	0·014	0·011	...	...
3000. . . . .	0·006	...	0·004	0·007

While all of the locomotives for which data are given were assumed to be balanced compounds,

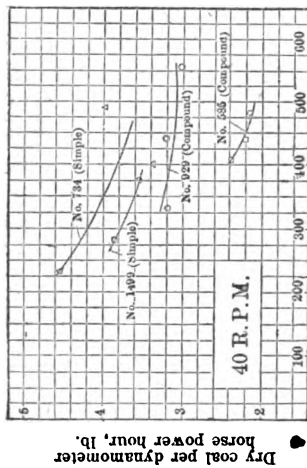


Fig. 20. — Dry coal per D. H. P. hour, freight locomotives.

Dynamometer horse power.

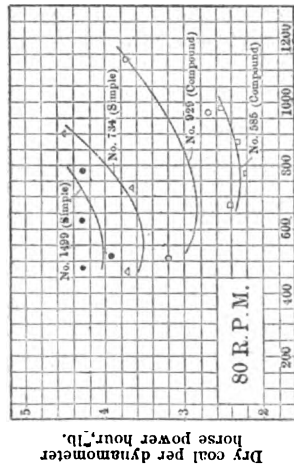


Fig. 21. — Dry coal per D. H. P. hour, freight locomotives.

Dynamometer horse power.

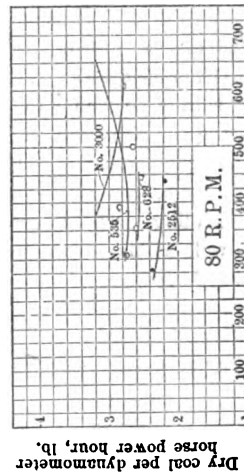


Fig. 23. — Dry coal per D. H. P. hour, passenger locomotives.

Dynamometer horse power.



Fig. 24. — Dry coal per D. H. P. hour, passenger locomotives.

Dynamometer horse power.

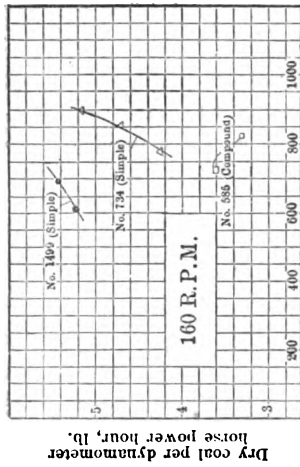


Fig. 22. — Dry coal per D. H. P. hour, freight locomotives.

Dynamometer horse power.

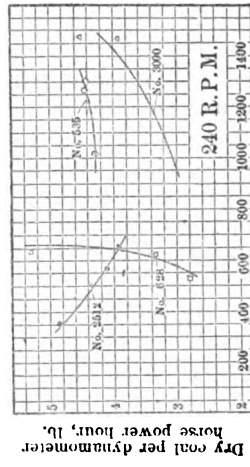


Fig. 25. — Dry coal per D. H. P. hour, passenger locomotives.

Dynamometer horse power.

the results of the several tests emphasize the superior condition of balance of locomotive No. 3000. This engine ran with great steadiness at all speeds. It was the last, in the scale of speed, to affect the dynamometer, its nosing action, as measured from the movement of the pilot was much smaller than that of the other engines tested, and the impress left upon the wires which were passed under its drivers was practically uniform for all speeds. These results demonstrate that longitudinal steadiness combined with a high degree of uniformity in the pressure of wheel upon rail, may be secured by the adoption of a properly designed four-cylinder balanced engine.

*Performance at the Draw Bar.* — A study of the data will show that the amount of steam and coal per dynamometer horse-power hour required by the modern locomotive, is not only less than has commonly been supposed, but that it compares favourably with that required by other methods of traction. The consumption per dynamometer horse-power by the freight locomotives, is shown diagrammatically by figures 20, 21 and 22, from which it appears that the normal consumption for the simple locomotive is between  $3\frac{1}{2}$  and  $4\frac{1}{2}$  pounds, while that of the compounds may approach the low limit of 2 pounds. Of all the freight locomotives, the performance of No. 585, a two-cylinder compound built at the Schenectady Works of the American Locomotive Company, shows the highest efficiency. The performance of other freight locomotives, both simple and compound, in terms of that of No. 585, is given by table XIX.

**Table XIX.**

FREIGHT LOCOMOTIVE NUMBER.	40 revolutions per minute.	80 revolutions per minute.	160 revolutions per minute.
1499 . . . . .	1.65	1.75	1.54
734 . . . . .	1.77	1.66	1.36
585 . . . . .	1.00	1.00	1.00
929 . . . . .	1.41	1.34	...

The upward turn of certain of the curves at the higher speeds (figs. 20 to 22) is an indication that power is being obtained at the expense of economy. For example, at 80 revolutions (fig. 21), it is clear that the several locomotives tested are most efficient when developing at the draw-bar between 600 and 800 horse-power, and that when forced to deliver a thousand or more, the cost per unit of power increases. The tests emphasize the desirability of using locomotives having an ample margin of power for the work to be done.

The cost of power at the draw-bar of the passenger locomotives tested, all of which were four-cylinder balanced compounds, is well shown by figures 23, 24 and 25. While the values in all cases are low, these, to a greater degree than those from the simple engines, show the disadvantage of overloading. The diagrams serve well to show the enormous output of power at the draw-bar as well as the satisfactory performance of locomotive No. 3000, built by the American Locomotive Company.

## THE TELEPHONE IN RAILROAD SERVICE,

By. H. L. BURDICK and W. T. SAUNDERS.

---

(*Railway Age.*)

---

The telephone has attained a recognized position as a factor of considerable value in railway operation and especially is the telephone becoming indispensable to the traffic department in its relation to possible or actual customers.

In fact, the development of the telephone in the railroad field, has, up to the present time, been largely influenced by traffic demands. Where the centers of population are large, and located within comparatively short distances of each other, the demands of the traffic department for means of quick connection with the public, and with the division headquarters of the department itself, have forced upon the railroad management the telephone as the only means to the desired end.

Having once installed a telephone system, the railroad in order to use the system to its full capacity, has been obliged to allow the various departments, operating, traffic, claim, legal, etc., to utilize the telephone circuits. The traffic department originating the demand for telephone service, did not, at the beginning, require the full use of the system.

When, however, other departments of the railroad began to demand the circuit time of the telephone system, it was found that the telephone was supplying an aid to the carrying on of railroad business, the need of which had not been recognized, and, in consequence, the telephone facilities of a number of railroads have been increased to meet the demands.

The growth of the telephone service among railroads is purely a natural result of ordinary business methods, since the average business man to-day has learned to do a large part of his work by means of the telephone.

The railroad receives from the public inquiries for the reservation of traveling accommodations, inquiries pertaining to incoming freight, freight rates and shipping facilities. This being the case, the railroads have found it necessary to equip many of their offices in large business centers with telephones. A very large part of the business carried on is transacted between its own officials, and the growth of telephone communication at the principal terminals resulted naturally in the establishing of private branch exchanges. This gave the desired result as far as the individual city was concerned, but the necessity of quick communication between different points on the lines soon brought about the construction of private telephone circuits on the railroad right of way.

It is necessary to the successful handling of traffic that the freight office, as a starting point, should not be so limited in telephone facilities as to invite censure from the merchant, and the

contracting agent, like the freight agent, must be able to render as satisfactory service by telephone as through a personal call. Both the officials must then be equipped with information which, if not absolutely at hand, can be shortly obtained. To this end, the railroad must extend its telephone service to the offices, junction points, and yards where this information can be obtained, and in this way the telephone system gradually extends over the railroad system.

However well a railroad is equipped with telegraph lines there is always an over supply of messages hanging on the hook waiting their turn for transmission. The railroad building a metallic circuit for telephone purposes can equip that circuit with apparatus by the use of which each wire can be utilized for telegraph purposes without interfering with the use of the circuit for the telephone.

One of the valuable uses of the telephone to railroads is that of the emergency portable set, which, carried on the baggage car, can be attached to the telephone circuit at any point, and by which, in case of accident or delay, the nearest division point can be notified. In cases where a railroad is not equipped with a metallic circuit, and does not appreciate the value of the telephone service sufficiently to spend money for such circuits, a type of apparatus has been developed for use on grounded telegraph lines, without interference with the Morse signals. This apparatus gives commercial service for limited distances, and while rendering good service, is principally valuable as an educational factor as to the value of telephone service.

The officials of a number of railroads have realized the great advantage of being able to communicate from any point on their road with their fellow officials, or with employees, at any other point on the system. Especially is this the case where the railroad has developed private branch exchanges — connected with the public exchanges in the principal business centers — as not only railroad officials but the general public can be reached over the railroad telephone lines through these private branch exchanges.

A description of the telephone development on the Burlington system indicates how railroad telephone development has advanced, and it is proposed to give a short description of the uses to which the telephone is put on this road.

#### *Telephone system on the Burlington.*

The Burlington system is operated under two grand divisions — the lines East of the Missouri, with headquarters at Chicago, and the lines West of the Missouri, with headquarters at Omaha. Each grand division is controlled by a general manager reporting to the vice-president. The grand divisions are each further separated into semi-grand divisions under the control of division superintendents.

The private lines constructed so far have been built to connect the officials at the important operating and traffic points.

In the extreme western portion of the territory covered there, are a number of short private lines constructed for operating purposes only, and these lines are referred to further on.

At present the four private branch exchanges in Chicago are connected with the exchanges in Aurora, a division point, Galesburg, Burlington, which is the headquarters of a semi-grand division, and also a division point, and West Burlington, where large shops are located.

In this section, there is a copper metallic circuit, the copper wire weighing 210 pounds per mile, connecting all the above mentioned exchanges.

This copper circuit is "simplex", that is to say, in addition to the telephone circuit it furnishes also a "quad" telegraph circuit, which adds considerably to the value of the install-

ation In addition to the copper circuit, between Chicago and Aurora, there is an iron circuit which carries standard composite equipment, giving a single telegraph circuit for each wire of the pair, and a telephone circuit over the pair of wires, making three valuable circuits from the single pair of wires.

The railroad exchange in St. Louis, which is a semi-grand division point, is connected by a copper metallic circuit, which also carries a "quad" telegraph circuit, with Hannibal, a division point.

The Kansas City exchange is connected with St. Joseph, a division point, by a similar copper metallic circuit. To avoid repetition, it may be stated here that the copper used by the Burlington is, up to the present, 210-pound wire, and that where such a copper circuit is constructed for telephone use, it in all cases furnishes also a "quad" telegraph circuit.

The Omaha exchange, a grand division point, is connected by a copper metallic circuit, with the exchanges in Lincoln, a semi-grand division point, and Havelock, where large shops are located.

The private branch exchanges at Rock Island, St. Paul and Denver, are at present not connected by private lines with the other large centers of the road, though it is probable that the rapid growth of the use of the telephone on this system will demand that these points be taken into the family. Naturally the centralization of important railroad terminals and operating points is demanded by the existence of a telephone system, which has proved of value to all departments of the railroad.

To give briefly the uses to which the telephone circuits are put, reference is made to the Chicago-Galesburg division only, as there is practically little difference in the uses of the telephone on any of the divisions, with the exception of the far western divisions, which will be mentioned in another paragraph.

The officials of the traffic department have regular communication with the local men of the department in regard to the securing of business, and, what is just as important, have access to the operating officials in regard to the handling of business when it is secured. Information of this kind can be secured by conversation over the telephone, where by telegraph, considerable correspondence would be necessary and much delay experienced.

The passenger department uses the circuits largely for information as to the reservation of accommodations. For instance, when a person from the western end of this division had occasion to leave for the Pacific Coast on short notice and had the option of other routes than the Burlington, the passenger agent in this section was able in a few minutes to secure sleeping car reservations and secured the customer as well.

The supply department is stated to be the largest user of the telephone facilities. The purchasing agent and the superintendent of supplies, located in Chicago, have direct communication with the men in charge of the storehouses throughout the division. The question of supplies is an important one to the railroad, and the handling of "hurry up" or "emergency" orders can be done by telephone to much greater advantage than by telegraph.

The operating department makes use of the circuits, especially in that the Chicago dispatcher and trainmaster can arrange freight service with division points. In this class of service, the railroad cannot arbitrarily run regular trains, but must arrange the service according to the business in sight and the daily demand for transportation facilities. Trainmasters and dispatchers regularly, twice a day, discuss these questions, and arrange their business accordingly. Very often, also, the telephone is used by them to meet emergency cases. It is stated that, by the use of the telephone on this division, the road saved running ten train crews over a considerable distance, in one month. This means a saving of cash.

As an instance of the value of the telephone when an emergency arises, it happened that, not long ago, when the road was short of coal, a mine owner at Streator, Ill., called the purchasing agent by long distance telephone and informed him that there were several hundred tons of coal on hand, but no transportation facilities. The purchasing agent over the railroad circuit to Aurora, found that there was a "way freight" on the way to Streator, arranged with the division superintendent to side-track the freight, and take the empties as a special to Streator. This was an unusual condition and could hardly have been arranged by telegraph. The legal department, not long since, obtained information enabling it to settle at once a claim arising from an accident to an employee, in a case where the telegraph could not have settled the matter in time, owing to the extensive details requiring personal conversation.

The transportation, claim, in fact, all the departments, have found use for the telephone, and are finding new uses to such an extent that the telephone facilities are put to a thorough test.

On the western divisions from Ravenna, Neb., to Billings, Mont., the telephone is put to a practical operating use. In a sparsely settled country, with a few places of importance along the road, it becomes necessary to have many "blind sidings". It is almost, if not quite, impossible to station telegraph operators at such points, or to keep them in such surroundings. In this section, grounded iron telephone circuits are constructed from dispatching points, or a station where a telegraph operator is located, with telephone instruments cut in at the blind sidings. A train given a meeting point at one of these sidings can, if delayed by the non-arrival of the other train, call up the nearest telegraph station and secure orders from the dispatcher. Some thirty-five sidings are cared for in this manner, and the service is found thoroughly satisfactory. Of course, in cases of this kind, composite apparatus could be used on the telegraph lines of the railroad. The officials of the Burlington, however, on account of the simplicity of the ordinary apparatus, the outlying points at which it is located, and the saving in maintenance of the ordinary telephone over that of the railway composite apparatus, have decided it cheaper in many cases to string a special wire for telephone use.

The Burlington has a number of sets of railway composite telephones in use at points where line conditions afford good service, and where proper attention can be paid to the maintenance of the apparatus.

The writers are indebted to Mr. W. W. Ryder, superintendent of telegraph of the Burlington, for much of the foregoing information.

#### *The probable development of railroad telephones.*

Although but one railroad system has been discussed, almost all the large railroads have begun the development of telephone service. A railroad starts the development of its telephone service through the necessity of reaching the public, and, especially in the thickly settled sections of the country, the railroads have installed private branch exchanges for the purpose of giving all their departments ample facilities in reaching business concerns.

Many railroads have also been convinced that the handling of their yards can be better done by telephone than by telegraph, and have accordingly built lines throughout their yards for this purpose. Where these yards are in close proximity to the private branch exchanges, they have been connected with these exchanges, thereby giving the officials of the road connection with an important part of the railroad system. It has been found important, especially as concerns train movements, that division points be connected, and the fact that yard lines have been established gives an opening for larger growth in telephone fields. One fact in particular encourages this

growth, and that is that the telephone circuit can be utilized as a telegraph circuit without interfering with the use of the circuit for telephone business.

In this connection, it may be well to say that railroads are beginning to realize the importance of building copper circuits instead of iron, for while the copper costs much more originally there is no deterioration in the metal from oxidization — and while iron wire in a few years becomes valueless, the copper can be taken down, if necessity demands, and sold for junk for at least at 75 per cent of its original cost.

Having the fact in view that the division points of a railroad demand telephone communication, it is well for the road, in constructing the original circuits, to use wire heavy enough to give good transmission over the whole system. With the establishing of block signal systems, it may be well to point out the fact that it is impossible at each block signal to instal a telephone. If a train on a double-track road is held up by the signal for an unusual time, it is possible that the conductor may, by the use of the telephone, get in touch with the dispatcher and obtain orders to run around the cause of delay.

A railroad can, without large outlay, gradually cover its whole system with telephone circuits. If only the advantages shown in this article accrue to the railroad, something is gained, but when it is considered that the telephone does not require expert knowledge of telegraphy, and that in case of differences with organized labor, the roads can manage to continue operating, it would seem that the telephone is becoming a necessity to the railroad and cannot much longer be denied a place in operating.

The question of whether a railroad should own or rent its telephone sets, for private line use, does not enter into the problem to any great extent. If a railroad pays \$12 for a set of telephone instruments — the life of which set, for railroad private line use, is six years — the road must lay aside \$2 per year, on the original cost, to pay for the set. There is also a charge of 5 per cent on the investment, or 60 cents per year. Beyond this, there is the replacing of broken parts of instruments, which, taking into consideration the fact that these sets, on private lines in yards, are subjected to comparatively rough usage, cannot be less than 5 per cent on the original investment. This amounts to an additional 60 cents per year. As a total, then, the railroad pays \$3.20 per year for each set owned.

If these sets are owned by the road, they cannot at present be connected with the general public, nor with the majority of railroad, for the majority of roads rent their telephone sets. The road must also take into account the fact that the sets owned, if destroyed by fire, flood or any other cause, are a total loss, while sets, if rented, must be replaced by the telephone company.

In whatever manner the telephone is adopted by the railroad company, it would seem that the facility of reaching the public, the saving in the handling of yards, the possibility of combining the telegraph circuit and the telephone circuit, the added facilities for train movements, the making-up of freights, and lastly, the exemption from tie-up on account of organized labor, would render it indispensable that live railroads be, within a few years, fully equipped throughout their entire systems with telephone facilities.

---



# PROCEEDINGS

OF THE  
SEVENTH SESSION

WASHINGTON : MAY, 1905

---

4<sup>th</sup> SECTION. — GENERAL.

---

[ 686 .237 ]

QUESTION XIV.

---

## BOOK-KEEPING

---

*Book-keeping generally. Description of the different existing systems;  
comparison from the double point of view of efficiency and economy.  
The question of adopting one uniform system on the different railways.*

*Reporters :*

*America.* — Mr. A. H. PLANT, comptroller, Southern Railway.

*Russia.* — Mr. Jean DE RICHTER, chef adjoint de la ligne Saint-Pétersbourg-Varsovie des chemins de fer de l'Empire russe.

*Other countries.* — Le chevalier A. von LÖHR, ingénieur, conseiller I. R. de régence, chef de division à la direction du chemin de fer autrichien Nord Empereur-Ferdinand.

---

## QUESTION XIV.

---

## CONTENTS

---

	Pages.
Sectional discussion . . . . .	1825
Sectional report . . . . .	1846
Discussion at the general meeting. . . . .	1846
Conclusions . . . . .	1849
Appendix : Letter from J. DE RICHTER, reporter, concerning the conclusions of his report . . . . .	1851

### PRELIMINARY DOCUMENTS.

Report No. 1 (all countries, except America and Russia), by chevalier A. von LÖNN. (See the *Bulletin* of February, 1903, 1<sup>st</sup> part, p. 579.)

Report No. 2 (Russia), by Jean DE RICHTER. (See the *Bulletin* of March, 1903, p. 1037.)

Report No. 3 (America), by A. H. PLANT. (See the *Bulletin* of February, 1903, 2<sup>nd</sup> part, p. 701.)

Vide also the separate issues (in red cover) Nos. 28, 31 and 38.

---

---

## SECTIONAL DISCUSSION

---

**Meeting held on May 6, 1905 (morning).**

---

**MR. ÉMILE HEURTEAU, PRESIDENT, IN THE CHAIR.**

**The President.** (In French.) — We shall now take up the XIV<sup>th</sup> question, dealing with bookkeeping. Upon this subject we have before us three reports, one by Mr. J. de Richter, another by Mr. von Löhr and a third by Mr. Plant.

Mr. de Richter is not present, but he has sent a letter which will appear in the proceedings. In it he lays stress upon the conclusions contained in his report. I do not think his letter alters any of the conclusions of his report or that I need now read it aloud, but it will be reproduced as an appendix to the shorthand reports of the proceedings. (*See the appendix.*)

Mr. von Löhr and Mr. Plant are here, and I shall therefore ask them to be good enough to summarize their papers.

**Mr. A. H. Plant, reporter for America.** — The conclusions of my report run as follows :

I have outlined the creation of an American railway accounting department, and briefly referred to the necessity for such an organization. While the responsibilities originally assigned to the chief accounting officer were faithfully and efficiently discharged, his sphere of duty and obligations to his company broadened with the passage of years.

As the commerce of America expanded, new and complex conditions of operations presented themselves, necessitating improved accounting methods; these conditions, though resulting finally in ordinary debits and credits, required an experimental acquaintance with intricate railway operations in order to be met successfully and directed into those accounting channels which would most surely promote efficiency and economy.

The progressive American railway accounting officer, therefore, fills a position which requires knowledge far beyond that possessed by the bookkeeper or accountant. It is to the result thus attainable through him that my conclusion will be mainly confined.

Uniformity in American railway accounting methods along general lines, is both possible and conducive to economy, and it is in process of rapid accomplishment through the medium of the Association of American Railway Accounting Officers. Physical, operating and traffic conditions are so varied, however, that I much doubt the advisability of attempting to unify the minor

details. It would be extravagance embodied to introduce on the smaller railways the elaborate methods employed by the larger lines for keeping their accounts; while, on the other hand, serious losses would follow the introduction of methods adequate for the smaller lines to those railways which earn, say, 50 millions of dollars annually.

Nevertheless, there are two factors of railway accounting which are capable of universal application, and which, if intelligently and persistently employed, would undoubtedly prove economically profitable. They are :

- a) The general introduction of interline way-billing for freights interchanged by railways, either through individual accounting departments or the medium of clearing houses;
- b) The compilation of comprehensive statistics presenting quickly units of production and of specific costs.

The freight traffic of America is growing fast; producers are every year seeking and supplying more distant consumers, and this leads to increased interchanges of traffic between carriers.

The usual accounting methods require the re-waybilling of freight traffic interchanged at each point of junction, necessitating elaborate and expensive station organizations, and resulting in delays and not infrequently in losses and damages.

The expense, delays and losses thus caused, may be materially reduced by the introduction of interline way-billing to all freights interchanged between carriers. Doubtless such an innovation would increase the cost to audit; but that cost would, I am sure, be more than offset by the saving in costs incidental to delays, losses and damages, and the decrease in costs to audit freight claims, which would reach their minimum under such methods.

The increased cost to audit would be confined to the apportionment of revenues between interested carriers on arbitrary bases, which would necessitate a separate apportionment of revenues on every way-bill, but that increase could be obviated by the general introduction of percentages for the division of through rates.

A central clearing house at Buffalo, N. Y., through which revenues on freight interchanged between certain allied lines are cleared, has been in operation for six years. Its work has enlarged in scope and improved in efficiency, and now embraces, in addition to the freights interchanged between its originators, trans-continental and fast freight line traffic.

The unit of cost to audit 1 dollar of freight revenue, both local and through, varies on different lines. On a representative railway, the freight revenues of which approximate 30 million dollars annually, the unit of cost — excluding cost to audit freight claims, but including cost to produce statistical data — is found to be three and one-half ( $3\frac{1}{2}$ ) mills.

Competition, compelling lower rates, and the organization of labor, resulting in at least standard wages, make it necessary for American railway managers, especially those in the United States, to look carefully to items of cost to produce.

The quick and intelligent deduction of units of costs, and their effective application to conditions as they arise, would in the opinion of the writer bring gratifying results.

Being neutral, having to do with all branches of railway operations and having at his command the material from which all railway statistics are compiled, it is possible for the chief accounting officer, by the prompt computation of units of costs, to materially increase the net profits of the company he represents.

**The President.** (In French.) — We are much obliged to Mr. Plant for his paper. Have any of you anything to say upon it?

**Mr. A. H. Plant.** — I have but little further to say in connection with my report on bookkeeping, except to express the opinion that the concentration of all matters pertaining to accounts under one departmental head, including the compilation of statistics, is most desirable and economical. The question of adopting one uniform system of accounts on all railway has had very serious consideration, and, as stated in my conclusions, I doubt the advisability of confining the accounts of all railways to one uniform method. Uniformity on general lines is advisable and economical. But the conditions are so different on different railways that I doubt seriously the advisability of attempting to unify, in every sense of the word, the accounts of all railway systems. The interchange of freight traffic between American railway lines is a very important feature of accounting. On a number of western lines, and some of the eastern lines of the United States, through freights passing over two or more transportation lines, are waybilled from starting point to destination without being rebilled at junction points. This is what we term interline waybilling. It avoids the necessity of re-waybilling at intermediate junction points, and obviates the necessity of settlements between carriers at such junction points. In the opinion of your reporter, the general introduction of interline waybilling for all freights passing over two or more carriers, is most desirable, and will add greatly to the reduction of cost to audit, and also tend to expedite the movement of traffic. In order to accomplish the result attainable through the medium of interline waybilling just referred to, there has been established a clearing house in one section of the United States for the purpose of clearing the revenues on all freight traffic interchanged between certain allied carriers and fast freight lines. The clearing house has been in operation something over six years, and while I am advised that it has proved satisfactory so far, I am of opinion that as a general proposition, by reason of various conditions existing in America, the introduction of the clearing house as a medium of clearing freight revenues generally, would be cumbersome, expensive and impracticable. My conclusions are that the only practicable method of clearing through freight passing over the lines of two or more carriers, is through the medium of interline waybilling, with what is known as audit office settlements.

**The President.** (In French.) — We tender our thanks to Mr. Plant for his very interesting remarks, and we will now hear what the other reporters have to say before opening the discussion upon the conclusions.

**Mr. von Löhr,** *reporter for all countries, except America and Russia.* (In French.) — You will find in my paper a general review of the question of bookkeeping as it now stands. I shall only take up the resulting conclusions which are open to criticism.

The subject is very complex; it is no easy matter to make a concise summary. We three reporters, Mr. de Richter, Mr. Plant and I, have come to much the same conclusion, namely that we ought to get as much centralization and as much simplicity as possible in accounting.

At the end of my report, you will find a few projects of resolutions which I propose for discussion.

Here they are :

1° The organization of the system of accountancy depends so much on the local and special conditions and necessities of each railway, that it cannot form the subject of definite rules universally applicable;

2° The centralization of the accountants department has given excellent results on those railways which have adopted it;

3° Railway budgets should not show, by their figures, definite and rigidly fixed amounts for the greater part of the figures, but rather a scheme, because the conditions of railway work require elasticity between wide limits according to the circumstances existing at the time;

4° The classification of expenses and revenue should be as simple as possible and as similar as possible in different countries. Statistics which cover a wide field should be kept separate from the accounts proper;

5° The powers of authorizing and ordering payment should be rigorously defined and as far as possible centralized; the cashiers office should be organized as simply as possible, and in such manner as to involve the minimum amount of transference of specie possible, any reasonable exceptions of course being permitted;

6° The organization of stations account, of audit, of distribution of revenue should be as simple and clear as possible; with this object, it is advisable to eliminate the small sums from the accounts and audit by the use of rational methods (franking stamps, abstract statements, automatic machines, season or contract tickets, cash registers, etc.);

7° Consequently, it is of importance that the study and trial of simplifications should be earnestly proceeded with;

8° The greatest use should be made of all modern arrangements destined to facilitate the work of the clerical accountants and cashiers staff (for example typewriters, copying devices, calculating machines, cheques and drafts, etc.).

Such are the conclusions that I suggest.

**The President.** (In French.) — We have heard the conclusions proposed by Mr. Plant and by Mr. von Löhr; we shall next have those suggested by Mr. de Richter.

**Mr. Margot, principal secretary.** (In French.) — Here are Mr. de Richter's conclusions :

Our paper comprises three principal parts, *viz.* : 1° a description of the different systems; 2° a comparison between them as regards efficiency and economy, and 3° introduction of uniformity in the system of accounts of the various railways. These three problems may be summed up as follows.

#### 1° First problem.

There exists in Russia only one system of railway accounts, *viz.* : that laid down by the Commission of 1884, with a view to a more complete check on the financial management of the concessionary companies. Being bequeathed by this Commission to the State railways, at the

time when taken over this system underwent a singular complication, chiefly due to three factors : a) the relation between the railway estimates and the legislation affecting the State budget; b) centralization as regards the financial treasuries at the Ministry of Finance, and c) establishment of a financial control quite independent of the administrative authorities.

Besides these general features, there are certain incidental differences to be noted, on which we will only touch briefly.

A. — ESTIMATES.

*Closing of estimates.* — On the companies' systems, *towards the period of drawing up the report for the financial year*; on the State railways, *three months after the expiration of the financial year.*

B. — GENERAL ACCOUNTANCY.

*Centralization of the general accountancy of the companies' systems, at the central management, with delegation of the accountancy to the local offices and to the main service branches; centralization of the general accountancy of State railways at the local office of each system, with delegation of the receipts and expenditure accountancy to the respective service branches.*

C. — RECEIPTS.

Entering the receipts of the companies' lines on the basis of the transactions, and independently of the cash settlement in respect thereof, either at the departure or on arrival; entering the receipts of the State railways on the basis of the transactions at the paying in offices, and without taking account of the remainder of the transactions.

D. — EXPENDITURE.

Accounting for outgoing stores, on the companies' railways, at the respective cost price on entering; on the State railways at average prices laid down in the schedule of prices.

2° Second problem.

The economic principle of the second problem consists in obtaining the *maximum effect* with a *minimum of labour and expense*. This principle implies : 1° a *division* of the productive factors, that is to say, in the *labour* involved by the accountancy and financial supervision, and 2° a *simplification of the machinery for management of finance, accountancy, and the supervision thereof*.

To apply this maxim to the State railways, it would be necessary above all, to lessen the influence of the three principal factors which complicate the arrangement referred to above under 1°. The first of these factors could only be remedied by detaching estimates for the State railways from the *general budget* of the State, save the carrying over, to the latter, of the ultimate balance from the State railway estimates; the influence of the second factor could be lessened by investing the paying-in offices with administrative power as regards the expenditure service (as in Belgium) and that of the third factors by *co-ordinating the inspection department*, entrusted with general supervising power and acting on the spot, and *giving to it the administrative accountancy work*. Of course these two services should : 1° be appropriate to the actual needs; 2° have a well defined practical aim, and 3° constitute an *organic whole*.

A. — CONDITIONS OF EFFICIENCY. MEANS OF OBTAINING THE MAXIMUM EFFECT.

Accountancy being only a means of tracing transactions in all their details, should meet the following requirements: 1° it should record all transactions, as they arise; 2° check them as to regularity, legality and utility; 3° classify them according to the system of accounts; 4° post them to the respective accounts; 5° balance the accounts at least once a year; 6° shew the balance; 7° draw up the balance sheet and 8° see to the settlement and clearing of the accounts through the pay offices and other credit institutions.

As the assets of the balance sheet represent the credit side, and the liabilities the debit side of the concern, railway accounts should record the transactions independent of the settlement or clearing of the transaction. Hence the accounts must record the *de jure* rather than *de facto* aspect of the transactions, contrary to the system of accounts in the financial offices, which deals with the *de facto* cash transactions only.

Any system of accounts arranged with a view to the balance sheet, must be on the double entry bookkeeping system, whereas a system arranged with a view to compliance with the estimates by the finance offices, may be conducted by single entry.

If the State becomes a producer of economic assets, if it constructs and works railways, etc., the object of its accountancy should be the balance sheet, and its system of bookkeeping should be double entry, as it is with commercial undertakings which recognize no other object or system of accounts.

The object of Russian railway accountancy, as indicated by the Commission of 1884, is none other than the balance sheet of the concern, the ultimate aim of double entry. It comprises both the successive transformations of economic values and the operations of the finance departments.

The object of the accounts of the State finance offices, and the financial supervision exercised by the Court of accounts in Russia, is simply the budget balance shown by a system of single entry bookkeeping. It merely deals with the ordinary application of the funds received (incomings, outgoings and cash in hand).

The antagonism between the administrative and executive authorities and the financial supervisors of the Russian railways, is the logical outcome of the divergent views as to the object of bookkeeping and the procedure appropriate to each respective object (balance sheet of the concern, and balance of the budget). It might be said that the finance supervising departments fancy themselves still in the 18<sup>th</sup> century, that is to say, in a period when the functions of the State were restricted to the maintenance of the civil and military forces and the sinews of war.

If, in the exercise of their functions, the administrative and executive authorities are stronger than the financial supervisors (which mostly happens in the case of companies' railways), the system of official accountancy makes headway, whereas if, on the other hand, the financial supervisors dominate the official accountancy (which is the case with the State railways), the latter loses ground, without any advantage to the supervision.

If the system of accounts of the administrative authorities progresses, it will centralize itself, that is to say, it fortifies itself in relation to the executive branches. Fortified with all the insight possessed by the administrative authorities, it will succeed in establishing a thorough and professional check, the administrative authorities alone remaining outside its financial supervision. It becomes an urgent need, in that case, to organize a general supervision, absolutely independent of the administrative authorities. This is the function of the central management of the companies' railway systems and of the local institutions of the Court of accounts on the State railways.

As the concessionary companies are under *obligations to the State*, the difference between the different systems of financial supervision become so infinitesimal, that it is, so to say, no longer possible to distinguish the two twin sisters from each other. With us, this is practically the rule.

When financial supervision is exercised through the central management of the railway system, whether it is a preliminary or a subsequent check, a check on returns and vouchers, or an active supervision, it is an excellent thing, provided that it does not in any way hamper the regular working of the concern, and leaves to the administrative authorities their due share of initiative and responsibility.

When the financial check is exercised by a special institution, absolutely independent of the administrative authorities, such as the Court of accounts, the preliminary check is of no value except when preparing the estimates; the preliminary official check is simply an organized confusion of the administrative powers and of the financial supervising authorities, each exerting himself to watch his neighbour, but neither of them doing his own work. This system aims at the *form* rather than at the *substance*, and too often degenerates into a system of chicanery, which, in the end, only serves to swell the expenditure, at the cost of the contributories. This is why a subsequent supervision, embracing all the items of the balance sheet (not merely confining itself to seeing that the budget is complied with), exercised on the spot, should become the rule on the State railways. But this check, to be effective, should avoid the habitual tardiness, and be arranged so that the administrative and executive authorities are really responsible for it.

Active supervision is only a supplementary measure, and is of no value unless the supervision of the vouchers and returns, and of the accounts, is adequately organized.

#### B. — ECONOMICAL CONDITIONS.

(Principle of minimum of labour.)

To attain this end, it is requisite to do only what is *strictly necessary*, never doing the same thing twice over, and to proportion the labour (and the expense) to the *object* of the accountancy and the supervision thereof. That is to say, the machinery of administration and accountancy must be simplified, the management of financial transactions decentralized, the accountancy centralized, and the accountancy and audit departments so co-ordinated, that they may, without overlapping, be each the complement to the other. Lastly, it is necessary to have an experienced and trustworthy staff for the accounts and audit.

To ensure simplification of the administrative machinery, and decentralization of the financial management, it is necessary to follow up, unceasingly, the progress of railway science, and its application to the various railway systems. But it is not for us to deal with this vast subject, which is entirely outside the compass of our task.

To simplify the machinery of accountancy, it must in the first place be centralized, so as to avoid repetitions, and to adapt the procedure to the nature and importance of the object, to arrange the drawing up and classification of the accounts so that, when checked by the accountants and auditors, they will simply require correcting and totalling once, but no organic alteration; and the limit periods fixed for the accounts should be as long as possible without prejudice to the principle of a constant check on the financial transactions.

To co-ordinate the functions of accountancy and audit, it is necessary to proceed to a rational division of their functions and to combine them in an organic fashion; we must discard prejudice

and avoid office routine. Financial supervision, as in all human institutions, should have a practical and clearly defined object; it should follow a mode of procedure appropriate to the *nature and course* of the forms of official bookkeeping; it should choose its own place and time, and should endeavour to be, instead of a mere trade, exercised by any new-comer, if not a science, at least an art. In short, it should do neither too much nor too little, only just "the right thing in the right place", as the proverb says.

In fine, the staff, for bookkeeping and audit, should consist of persons of sufficient education and professional training, which amounts to saying that they must be remunerated proportionately to the services required of them; the salaries of this staff should even be increased, independently of their functions, in accordance with their years of service, in order to create a more stable and devoted body of officials, more especially at the stations, workshops and stores depots.

Last but not least, human labour should be superseded, when feasible, by the introduction of mechanical appliances, which we have already alluded to in discussing this question.

### 3° Third problem.

Uniformity is not so difficult to realize, if we confine ourselves to the general features of the problem, and disregard the details. The great reform to be effected to this end would be to find the line of demarcation. Meanwhile, we might stop to consider the more modest problem of introducing uniformity into the arrangement of the balance sheet, and of the estimates of expenditure on revenue account.

**The President.** (In French.) — We now have before us the conclusions prepared by our three reporters. They differ but little fundamentally and I now declare the discussion open upon these conclusions. Does anyone wish to speak?

**Mr. Lionel Marie,** French Northern Railway. (In French.) — The reports which have been submitted to you were drawn up by gentlemen quite well up in what is going on in America, in central Europe and in Russia, but they do not deal with the subject of bookkeeping as carried out on the French railways. Several of my French colleagues have, therefore, asked me to give you a rapid and concise account of our method, which in great measure satisfies the desiderata expressed in these reports.

When the Accountants' Conference for Central European countries met at Paris in 1900, delegates came in large numbers—in fact there were over a hundred. We expounded to these gentlemen the method of accounting practised by the whole of the French railway companies, with special reference to that of the Northern of France, which does not differ very appreciably from that used by the other companies.

We were able to show them that the accountancy instituted in France satisfied the two requisite desiderata: 1. easy and rapid confirmation of the results obtained, 2. method of getting better results.

The first essential is that throughout a company's business receipts and expendi-

ture should be clearly separated, that the earnings and expenses departments should be under different jurisdictions and subsequently be connected together under a single superior officer who classifies the results.

As regards receipts from home traffic, they are got out by the receipts accountants of each company; as regards receipts from through traffic, by the accountants common to all the French companies, and as regards international traffic, from the recapitulation statements based upon consignments when received and from the claims department situated either in Brussels or in Germany. In this way, there is a very thorough supervision of receipts for the whole batch of railways.

As for the expenses, they are likewise under the supervision of a departmental head who rapidly and urgently runs through all the expenditure charged, and he can thus, by comparing the receipts and expenses each month, for the previous month, arrive at the exact position of expenditure and earnings. Thus, by the results obtained, the traffic manager can modify the train movement according to the decrease or improvement in the traffic, so as to maintain, within the limit possible, expenditure on a reasonable basis.

The headquarter departments are greatly assisted by the supervising department directly controlled by the head of the receipts and expenditure department. It is the business of the latter to watch constantly all that goes on upon the line, either in some continuous way, or by sending out officials to make enquiries at once when urgent matters crop up. Being provided thus, the superintendent or traffic manager is kept informed very quickly. In the Northern Company, we get out the results of the previous month by the 18<sup>th</sup> of the succeeding month. Thus the position of the earnings and expenditure is very rapidly known.

I may add that various improvements to hurry the returns and to ensure satisfactory service have been introduced either at our stations or at the central offices by using writing machines, typewriters, and short-hand clerks, all the latest and best means, for our company possesses a large number of typewriting and calculating machines. The accounts are got out with wonderful speed, and bookkeeping is likewise carried out very fast.

Thus, in making out way-bills, when this work is being watched at our chief stations, it will be noticed that there are classifying-clerks who make out the rate with lightning rapidity; they do nothing else. The work is then passed on to calculators who make out the charge within the time it takes to turn a handle; the way-bills then go on to typewriters, who in a few minutes prepare several statements in the most regular and orderly manner. Each piece of work is thus done by skilled men and, as they are accustomed to it and as copies are made of everything, no mistakes occur.

I may add that one of the best safeguards you can get in these bookkeeping matters depends upon the principle of keeping the cashiers and accounting clerks, from top to bottom, constantly apart. This is a system which makes things most safe.

But though keeping the staff apart is easy at large stations, it is much more diffi-

cult at small ones. It is indeed hard to separate the staff at a station where for instance there is only one clerk, but we have obtained the same result by the following method : at small stations, it is the business of the staff to look after current business and to some extent to attend to the cash department, but all the monthly bookkeeping is done by travelling accountants who belong to a central point, and it is their duty to keep the books for small stations or stopping places in each district. We thus manage to subdivide and separate authority right down the scale.

I am only giving these data in a brief manner, because I do not want to waste the time of the meeting. I hoped to be able to show you in this way that thanks to our method we have succeeded in reaching a maximum amount of supervision and speed. We have indeed succeeded in getting the receipts and expenses separate, in directly and quickly supervising the expenses and receipts, in comparing the receipts and expenses each month within eighteen days from the close of the month, and any variations that may arise result in orders being given by the manager according to the circumstances of the moment. The separation of the cashier and the accountant, typed copies, the use of females in large numbers, the employment of typewriting machines, classifying-clerks, etc., such are the bases of our system. Despite all this, and though the simplifications have been very considerable among companies who have exceedingly delicate and complex relations with neighbouring companies, we have not succeeded in reaching as great simplification as we should like. Some companies have arrangements abroad, involving different methods of through booking, separate entries, etc. We find ourselves bound to arrange for more complicated bookkeeping in this respect, but as things are, thanks to these reforms the French Northern Railway has reached. I do not say absolute perfection, but has succeeded in attaining as nearly as possible the desiderata that have been expounded, *i. e.* a method of bookkeeping which provides every facility for obtaining the results which we want, and one that will make it possible to get even better results in the future.

**The President.** (In French.) — We are much obliged to you for the interesting information you have given us. Does anyone else wish to speak?

**Mr. C. P. Mossop,** North Eastern Railway, Great Britain. — **Mr. President,** I should like to ask Mr. Plant if in the inquiries that he has been making, he has considered whether the concentration of accounts is applicable to English railways. It seems to me the exclusion of express or light goods traffic, makes a great deal of difference in the amount of work that is thrown on the audit office. Every way-bill, as I understand it, is in America sent to the audit office, and there ascertainment of rates and tonnages are checked, notwithstanding that this has already been done at the receiving station. Taking the North Eastern Railway of England as an example, we have a large freight traffic. We try to concentrate the accounts as far as we can. On the heavy mineral traffic, there is no way-bill issued at all. The colliery compa-

nies make the declaration, and that declaration is accepted by the auditors, for charging purposes. Checking, of course, is done by wagon returns, and we test the weights occasionally; but no way-bill is issued at all for the huge movement of our mineral traffic, which traffic amounts to something like 40 million tons out of a total of 54 million tons a year. But the other 14 million tons of general merchandise traffic involves the issue of something like 10 million of invoices or way-bills, as you call them in your country. I was wondering whether the large quantity of way-bills, or the comparatively large quantity in relation to the tonnage, would make any difference in Mr. Plant's conclusion that these way-bills should be sent to be audited and checked again, although they are checked by qualified clerks at the receiving stations.

**Mr. Lionel Marie.** (In French.) — I beg to supply the following answer. The method we employ in no way excludes or is special to an individual railway system or to any particular country. Consignments can be despatched either in bulk or in broken loads, either in full truck loads or train loads; we have indeed on some French lines, a traffic like what has just been mentioned consisting of millions of tons carried without way-bills, but we, in France, always make out way-bills. For instance, the Northern of France Railway carries about 15 million tons of coal annually from the Northern and Pas-de-Calais mines. Every day an average of 50,000 tons is carried. All these consignments are effected under the system to which I have alluded, without a single exception, and I may add without any difficulty for the following very simple reason: in order to simplify matters even more than I explained just now, we arranged that the mining companies which get out the coal and load it on their private sidings, should, in the first, place themselves marshal the trucks and secondly prepare all the consignment notes.

These way-bills are not very difficult or very complicated, because the consignments, of which there are an immense number, are sent in batches, and one way-bill is enough for a whole series of trucks. These batches often amount to 200 tons, and consist at times of even twenty 20 ton wagons, or 400 tons for a single consignment, I may add that the whole thing is extremely easy. By agreement with the mining companies, we supply them with typewriting machines and printed forms, our own printed forms. Their staff fill in the consignment notes with our typewriting machines. These are very easy to prepare, because they are almost always for the same destination, as the companies are almost always shipping to the same points.

The result is that, for instance, in the mines of which I am speaking, the trucks supplied during the day are loaded that day, and handed over the same evening with all the way-bills classified to our staff, who have nothing to do but see that the number of way-bills handed over or the tonnage stated on these notes, corresponds accurately with the trucks that have been handed over loaded. The whole matter is therefore exceedingly simple. Accordingly, in reply to the question just asked, it

is very easy to make out the way-bills very expeditiously and very cheaply for consignments of goods in bulk.

As regards consignments of small parcels, for instance, by fast trains, here comes in, as I have told you, the subdivision of the work. The business is carried out with so much speed, that at festival times we find as many as 8,000, 10,000 or 15,000 consignments being dealt with at a single station within a few hours, and all the way-bills properly made out. It is an incontestable fact that the method we pursue has produced results which we find quite satisfactory, and that we are extending it throughout our system for all consignments despatched either by fast trains or in broken lots or in truck loads or in full train loads.

**Mr. A. H. Plant, reporter.** — Mr. President, in response to Mr. Mossop's question as to the way-billing of small package freight, I would say that physical conditions in the United States, and I may say in North America, with respect to package freights are somewhat different from what they are, as I take it, in England, in France, and in other places on the continent. In North America, regular organized express companies handle largely the parcel or package freights. Express companies contract with railroad companies to transport such freights in the trains and cars of the railroad companies. The express companies receive, way-bills, care for and deliver such packages; the railroad companies, therefore, do not as in England, France and continental Europe, transport this small package or parcel freight; therefore the necessity for way-billing and accounting for that class of traffic does not exist with the American railroad. However, it is customary with the express companies, to way-bill each package or parcel of freight handled by them in the same manner that the railway companies way-bill freights entrusted to their care. Each package or parcel of freight handled by the express companies, is way-billed. Two or more packages or consignments, however, originating at and destined to groups of stations, are way-billed on the same way-bill. It is the universal custom in America, to enter each consignment of freight on a way-bill. I do not wish to convey the idea that a separate way-bill is made for each consignment; on the other hand, it is the practice to enter on one way-bill a number of consignments going from and to the same destination *via* the same route when loaded in the same car. It is also the practice to way-bill on one way-bill a number of consignments from one station to various destinations *via* the same junction or terminal point, when loaded in the same car. Thus we have on one way-bill twenty, thirty or forty different shipments. The rule generally prohibits the way-billing on one way-bill of shipments loaded in more than one car. This rule, however, is deviated from on some of the lines having heavy coal traffic. It is the practice, of some lines, to way-bill on one way-bill a train-load of coal cars moving from one point to one destination. This method is followed on lines having a common destination for its coal. It is not practised by lines having a diversified coal traffic.

With respect to the remarks made by Mr. Marie, I wish say to that, as a general

proposition, the accounts of railways in the United States, in respect to receipts and disbursements, are kept by one general head, namely, the accounting department. The financial or treasury department is separate and distinct from the accounting department. The chief accounting officer has charge of the accounts of both revenue and expenditures. He also has charge of the general accounts of the company. It is possible, under American methods, to produce operating results for a given month within ten days after the close of the month for which reports are made. The time for producing operating results varies, however, according to the mileage of the line and amount of business done. Final results are obtained generally not later than thirty days after the close of the month on the largest American lines. General managers and division operating officers are furnished promptly with results of operations. As an illustration, I have in mind a line whose mileage is in excess of 7,000 miles of line, earnings between 40 and 50 million dollars annually. The results both as to operating expenses, in detail, together with statistical data showing the units of cost to produce, is completed and submitted to the operating officers within twenty-eight days after the close of the month. It will, therefore, be seen that it is possible for railways in America to produce quickly and satisfactorily reports showing operating conditions. Accounting officers of American railways are constantly striving to produce reports of operations which will bring quickly and intelligently to the attention of the operating officers the units of costs incidental to the production of traffic. In order to place such results quickly and intelligently before the operating officers of the lines I represent, I have been experimenting with graphic charts, on which the various units of costs to produce are shown. This method, in my opinion, will place before the operating officer quickly and comprehensively, the results of his operations. I shall be very glad to exhibit these charts to any of the members who may desire to see them, and explain the method through which they are being carried.

**Mr. Lionel Marie.** (In French.) — I quite agree with Mr. Plant. The method of organization impressed me much when I read Mr. Plant's report on bookkeeping. Still, with the organization we possess, we manage to do as follows quite normally and regularly : we have a railway which of course is not 7,000 miles long, but we own 4,000 kilometres (2,500 miles) and our traffic is very heavy. On the 18<sup>th</sup> of each month, we know the exact position of the receipts and expenses. Having this statement before him, the superintendent of the line can come to any decisions, deduce his conclusions and give instructions by the 20<sup>th</sup> as to what modifications he wants, either in the number of trains, or in their loading, etc. With absolute regularity and by no means exceptionally, I get a statement of all the expenditure on the 18<sup>th</sup> of each month. The head of the expenditure department sends them in ; they are transmitted two days later to the superintendent of the line who is in possession of all the facts to enable him to give his instructions by the 20<sup>th</sup> of the following

month. For instance, on the 20<sup>th</sup> of May he has the figures relating to the month of April, and this is the normal state of affairs.

**Mr. C. P. Mossop.** — Mr. President, Mr. Plant has not completely answered my inquiry. In regard to the heavy mineral traffic, namely coal, lime and limestone, we have not any difficulty at all. It is pure concentration of accounts, and we are the largest freight carriers in the world, measured by tons, except the Pennsylvania and German State railways. It is the general merchandise to which I refer, which amounts to 14 million of tons a year out of 34 million of tons. For this general merchandise, by freight trains we have to issue [notwithstanding that we use one way-bill for as many entries as pass between any pair of stations in the day] something like 10 million way-bills. It is easy to see how much work that would involve, if in addition to the ordinary accounting and statistical work, we have to go through, the checking of rates and charges was added. Would the difference in the number of entries make any difference in Mr. Plant's conclusion? Our interline way-billing is complete in England. We have not such a thing as re-booking from a junction. For every pair of stations we have a separate entry, and the amount of labour would be enormous if we were to follow out the first suggestion by Mr. Plant. We believe in concentration, if it can be done economically. I thought that Mr. Plant had given so much attention to it, that he might have come to some conclusion as to whether it would be economical for a big freight-carrying company in England to do it.

**Mr. A. H. Plant.** — Mr. President, in further response to Mr. Mossop's query, I will explain briefly how the traffic of the United States is way-billed. We will deal with what we term our merchandise traffic, that is, traffic from New York, the principal port, to the interior. Each separate consignment is way-billed. However, two or more consignments to the same destination may be placed on the same way-bill. As a result, all traffic forwarded from New York to Memphis, Tennessee, by one road and on one day, if loaded in the same car, can be way-billed on one way-bill necessitating only one entry in the audit office for that way-bill. But each piece of freight handled on the railways of the United States, must be accompanied by a way-bill, and on most of the roads, it matters not whether the freight be commercial or company freight, a way-bill must accompany it. Each way-bill, as a general proposition, — and it is almost universal — is reported by the forwarding agent to the accounting officer. A copy of the way-bill accompanies the report in a large number of cases; that is, on a large number of roads. On some roads, different methods prevail. At destination, the way-bill is carefully examined by the receiving agent. It is tested as to correctness of classification, rate and revenues. The way-bill is then reported by the receiving agent to the accounting officer of his line. The two reports, namely, the forwarded report and the received report, are checked and balanced, one against the other. In that way, the audit office has the record from both ends of the shipment as to the amount. They avoid the possibility

through that medium of losing track of the way-bill, or of its being suppressed by the agent. We have a record of the freight as it starts and as it is received. We check one record against the other, and assure ourselves we get revenue on every way-bill originated.

That, in substance, is our method of handling freight. In some of the audit offices, copies of the way-bills, as made by the forwarding agent, are carefully examined. The classifications, revenues, rates, and so forth, are tested in the audit office. In that way, we have two checks on the correctness of the way-billing, one in the audit office, the other in the agency at destination.

On quite a number of lines, the audit office check of rates, etc., has been abolished, believing that the cost to make that check would be greater than the saving therefrom. Experience on the Southern Railway demonstrated that fully 85 per cent of the errors discovered in the audit office were discovered and corrected by the destination agent. Therefore, we had a duplication of corrections. On that showing, I discontinued the expense in the audit office, because the saving did not justify the outlay.

**Mr. R. L. Wedgwood**, North Eastern Railway, Great Britain. — **Mr. President**, I hope the members of the section will excuse me if I refer to a subject that has been touched upon already this morning, although it has not been fully gone into, and that is the question of cost statistics.

The railway I represent has been considering the preparation of statistics of that kind, and we have not arrived at finality yet. We are at present getting out within a month after the date of the actual occurrences, statistics of the ton-miles worked per engine hour, but we recognize that that is not the final figure giving the cost of our working. We give the cost per ton-mile under the various classes of expenditure. To do that, we have found a good many difficulties to overcome, and it would interest me, and I think some others here, if we could learn from representatives of American railways, how they have overcome those difficulties. Perhaps **Mr. Plant** will be kind enough to enlighten us.

The first difficulty has been the division of expenses between freight and passenger traffic. We have not yet settled how to make that division. It is pretty clear at first sight, that division by receipts or by ton-miles would be unsatisfactory, and it would interest me to hear if American railways have gone into the question with a view of making an accurate division of the two classes of expenditure.

The second difficulty we have to encounter lies in the distinction between capital and revenue expenditure. There are a large number of items of expenditure where the location of the items is not decided at the time of the expenditure; it is perhaps left undecided for six months. I should be glad to know if the Southern Railway, for instance, in working out their operating statistics have distinguished between ordinary revenue expenditure and expenditure on improvements or on additional lines.

Thirdly, I should like to know whether anything has been done on American railways in the direction of obtaining statistics for each division separately as well as for the lines as a whole. I notice that in Mr. Plant's report, he gives a summary of the statistics for his line, and I judge from his report, that those statistics are tested by the percentage that the expenses bear to the receipts. That percentage varies very much from month to month, and it appears to me that the comparison must be a very unsatisfactory one. The expenditure on maintenance of way or of equipment varies very heavily from month to month, and that must make any comparison of one month with another month unsatisfactory.

**Mr. A. H. Plant.** — In reply to Mr. Wedgwood with respect to his three difficulties, I will say that in respect to the division of operating expenses as between freight and passenger traffic, I do not recall any railroad in the United States which has been successful in separating its costs of operation to produce passenger and freight revenue. It has been tried a number of times by different lines, but my opinion is that it was abandoned as being impracticable.

The Interstate Commerce Commission, a branch of the national government, which requires railroads of the United States to make annual reports and returns, for a time required the separation of operating costs as between passenger and freight. That requirement, however, was abandoned as being impracticable.

It is the practice of two or three American railways to apportion their operating expenses to passenger and to freight traffic. That apportionment is made, I might say, arbitrarily. Some of the costs are apportioned on basis of train miles and other costs on basis of engine miles, while still other costs, such as general expenses, are apportioned on basis of revenues earned. I feel sure, that the accounting officers making that apportionment, are not satisfied that it is equitable, or that the results arrived at accurately set forth the cost to produce either class of traffic. The apportionment made by those lines, as I understand it, is a matter of local information to the operating officers.

As to the second difficulty mentioned by Mr. Wedgwood, I advise that as a general rule, American railways do not encounter the difficulty mentioned. The lines between operating expenses, improvements and betterments and charges to capital account, are very clearly drawn, and as a general thing, American railways know to what account an expenditure will be charged at the time it is authorized or made. There is in existence a classification of operating expenses which is divided into four general heads, namely, maintenance of way and structures, maintenance of equipment, conducting transportation and general administration. Those four general heads are subdivided into various sub-heads, which include all items of expenditures incident to maintenance and operation, and to those sub-heads all expenditures incident to maintenance and operation are charged. A large number of American railways have what is known as an improvement and betterment account, to which is charged expenditures made for improvements and betterments which

cannot be properly classified as incidental to operations, and which are not chargeable to capital. Charges to capital account generally embrace all additions to property, such as new and additional equipment, additional or branch lines, real estate and similar acquisitions.

As to Mr. Wedgwood's third difficulty, namely, the production of operation statistics for each operating division as well as for the line as a whole, I will say that it is the practice, on a majority of American railways, to produce statistical data, both in respect to earnings and operating costs by operating divisions. Such results are produced monthly on the Southern Railway without difficulty, and are promptly reported to the division operating officers. Our practice is to first produce the revenues from the various sources and the operating expenses under their respective heads for the line as a whole. Those results are reduced, as far as practicable, to units of earnings and of costs for the several classes, after which both the revenues and operating costs are divided into districts, the results of which show the efficiency of the different districts into which the system is divided. The third division is between the several operating divisions in the various districts. Both the revenues and the costs are apportioned to operating divisions, on basis of accruals and reduced to units of earnings and units of costs. The results thus produced are used by the division operating officer in regulating and adjusting excessive costs to produce. It is true that the percentage of operating costs to revenues will fluctuate widely at times. Such fluctuation does not always indicate economical or extravagant operations, but when the revenues and the costs are reduced to units, the economical or extravagant operation is plainly shown, and through this method is susceptible of explanation and correction.

**Mr. C. W. Appleyard, Central South Africa Government Railways.** — Mr. President, in connection with what Mr. Plant has been good enough to tell us as to the methods of comparing statistics, I should very much like to have some additional information as to the method of arriving at sectional expenditure in statistics; I should like to know on what basis of expenditure the division is made as between different sections. In the Central South Africa Railways, we have a mileage of about 1,500 miles and, as conditions are not the same on different parts of the lines, the system is divided into several sections, and we attempt to work out our costs on each section; but a good many difficulties arise. Certain expenditure we can allocate pretty accurately, but over and above such expenditure there is general expenditure. One instance: general charges. I would like to know how that is divided in the case of American railways.

And as to expenditure on betterment, I notice from statistics of some American railways that, probably as the result of better working, the expenditure per ton per mile has decreased or did decrease up until about 1900, and that from 1900 the statistics show a tendency to an increase. I am referring now to statistics I have seen in reference to the Pennsylvania lines. I presume that that is due to certain

charges for betterment being included in working charges, and I should like to know whether that is included in the ton-mile costs.

There are certain other difficulties in regard to very expensive sections of the line. I am speaking now of Johannesburg, which you will probably recollect is practically in the centre of our system. The expenses of handling traffic in Johannesburg and vicinity are pretty high, and that has been treated for statistical purposes as a separate section of the line; but as the handling charges are heavy and as they are in respect of traffic passing over other sections of the line, it does not seem fair to charge the whole of the expenditure to the one section.

I should be glad to know from Mr. Plant whether in any similar zone in the United States, where the expenses of handling traffic are out of proportion to the ordinary expenditure, the charge is always made against that section of road.

**Mr. A. H. Plant.** — As to the question raised, I suppose we have the same conditions in America as my friend has in South Africa as to extra heavy lines. I know of but few instances where any difference in the general method of distributing operating expenses is made in respect to those heavy lines. As a general proposition, they are charged with their full proportions of cost to operate. I have known instances where those particular divisions were given in the distribution of the revenue a higher revenue percentage to overcome in a measure their physical disability. It is customary, on some lines in the division of revenues, particularly revenues from freights, to allow a certain arbitrary percentage of the revenue to each terminal line, to overcome the cost of handling, the intermediate line or division having no cost of that character whatever. In some cases where we have heavy terminal expenses, I have known cases where extra allowances were made from the revenues to overcome those costs.

As to the ratios mentioned in respect to the Pennsylvania Railroad, I beg to say that Mr. Riebenack, the comptroller of the Pennsylvania Railroad Company is with us, and I should prefer to have him explain that question. I think, though, as a general proposition the improvements and betterments which are not charged direct to operating expenses do not enter into the units of cost — they are excluded. In other words, our units of cost are confined entirely to such costs as enter into operating expenses.

**Mr. M. Riebenack,** Pennsylvania Railroad. — I did not clearly hear Mr. Appleyard's questions. What was the reference you made to the Pennsylvania Railroad Company?

**Mr. C. W. Appleyard.** — In the statistics, in the last report showing the cost per ton-mile, the figures show a tendency in a downward direction up to about 1900, I think, and then the cost per ton-mile begins to show a slight increase. I wondered whether that was due to the inclusion of the cost of betterments.

**Mr. M. Riebenack.** — No Sir, it is not. To go back to the reference to the ques-

tion of division of expenses, it is not possible to properly divide them between passenger and freight; the Pennsylvania Railroad Company has always divided these expenses on an arbitrary basis, which was started nearly forty years ago, and for our purposes, and for the information of the officers, it answers every requirement as to what course they will take in the management of the property. Our division is made on the basis of freight and passenger locomotive mileage, excluding work locomotive mileage, and our officers have always insisted on having it kept up and the results published in the annual report.

I do not claim that this method could be generally adopted; I think that the absolute division of freight and passenger expenses is impracticable, and impossible; but, if necessary, railroads can devise something to answer their purposes the same as we have done. We have taken the locomotive mile (freight and passenger), and other railroad companies can do this and obtain data which may meet their needs. A general rule cannot be established which will be satisfactory to every one.

**Mr. Lionel Marie.** (In French.) — Among the French companies we find no serious difficulty in working out the statistical results that are given each year in the annual returns, both in passenger and goods units.

**The President.** (In French.) — These difficulties unquestionably exist so far as concerns the apportionment of the expenditure common to the different kinds of traffic. This, I think, is what these gentlemen want to point out.

**Mr. Lionel Marie.** (In French.) — I must say, as a member of the International Institute of Statistics, that of the results sent in by all countries, the statistics that are transmitted to us from the United States, especially those prepared either by Mr. Putman or by Mr. Hyde for making out the census, form a really remarkable work, and we are impressed with the way in which statistical results are prepared in the United States.

**Mr. A. H. Plant.** — I should like to say, for the benefit of the members here, that while it is possible to divide operating expenses, that is, maintenance of way, maintenance of equipment, and general expenses — as between freight and passengers for specific purposes —, I must repeat that I do not believe it is possible to arrive at any exact conclusion as to the distribution of cost to produce passenger and freight revenues. There are certain elements, of course, in maintenance of equipment and transportation, which can be definitely determined and assigned to both or to either passenger or freight revenues; but there are other elements — and they predominate — which cannot be assigned accurately to either. Any basis of division attempted must be arbitrarily made and for local purposes.

**Mr. James Douglas,** El Paso & Southwestern Railroad, United States. — While that may be true, in regard to any particular railroad, it makes very little difference how we distribute the accounts. To the public at large, who look at these statistics,

of course, of ton mileage, one railroad makes a remarkable showing and the other does not. To what extent is that remarkable showing due to the way in which the distribution is made? Now, would it not be possible to have some uniform system of distribution, so that one railroad would not apparently make a very much better showing than it is entitled to, and another railroad make a poorer showing than it is entitled to. Would it be possible to devise a system of distribution which would be generally accepted and which would make the showing of one railroad virtually correspond to the showing of another road?

**Mr. A. H. Plant.** — I can see no object whatever in preparing statistics for general purposes unless they can be accurately prepared, and I am of opinion that if we produce on American railways statistics under any formula you please, for the sake of uniformity, that will show a unit of cost to produce a ton of freight, in a very short while afterwards an effort will be made to base rates per ton per mile on that unit of cost to produce. Now, I claim that inasmuch as we cannot accurately determine that cost to produce, it should not be a matter of general statistics.

**The President.** (In French.) — I think we have exhausted this discussion. We still have to formulate conclusions.

The following are those suggested by Mr. von Löhr and by Mr. Plant :

“ 1° The organization of the accounting department is so dependent on local and special conditions and requirements of each railway that it does not admit of any absolute rules of universal application.

“ 2° The centralization of the accounting department in each railroad administration has apparently given excellent results on those railways which have adopted it.

“ 3° Railway budgets should not show by their figures definite and rigidly fixed amounts, but for the greater part of the figures rather a framework, because the conditions of railway work require elasticity between wide limits, according to the circumstances existing at the time.

“ 4° The classification of expenditure and receipts should be as simple as possible, and as similar as possible in different countries.

“ 5° The powers of authorizing and ordering payments should be rigidly defined and as far as possible centralized; the cashier's office should be organized as simply as possible, and in such a manner as to involve the minimum amount of transfers of specie, any reasonable exceptions, of course, being permitted.

“ 6° The organization of station accounts, auditing and distribution of revenue, should be as simple and clear as possible. For this purpose, it is advisable to eliminate the small amounts from the accounts and audit by the use of improved methods, such as the use of express companies, franking stamps, abstract statements, automatic machines, season or contract tickets, cash registers and so forth.

“ 7° Consequently it is of importance that study and experiment with simplified measures should be earnestly continued.

“ 8° The most extensive use should be made of all modern devices for facilitating bookkeeping and clerical work — for example, typewriters, calculating machines, etc. ”

If no one has any remark to offer, these conclusions will be adopted and will be submitted to the general meeting.

---

## DISCUSSION AT THE GENERAL MEETING

---

Meeting held on May 12, 1905 (afternoon).

---

MR. STUYVESANT FISH, PRESIDENT, IN THE CHAIR.

GENERAL SECRETARY : MR. L. WEISSENBRUCH.

ASSOCIATE GENERAL SECRETARY : MR. W. F. ALLEN.

The President read the

### Report of the 4<sup>th</sup> section.

(See the *Daily Journal of the session*, No. 5, p. 89.)

“ Three reports, with extensive documents, were presented on this subject.

“ Mr. A. H. PLANT, reporter, drew the following conclusions : That it would be advantageous to centralize the accounting and statistical departments and make them as uniform as possible on different lines, and also to introduce and extend the use of interline way-billing for freights interchanged by railways, either through clearing houses or individual accounting departments.

“ Mr. VON LÖHR, reporter, presented his conclusions, recommending the centralization and simplification of the bookkeeping and the budgets of railways, also as extensive a use as possible of modern devices, such as typewriters and calculating machines.

“ Mr. DE RICHTER, reporter, who has made a study of the methods of bookkeeping employed in Russia had arrived at similar conclusions.

“ Completing the data furnished by the reporters, Mr. Lionel MARIE (*French Northern Railway*) and Mr. C. P. Mossop (*North Eastern Railway of England*) explained to the section what is being done, respectively, in France and England : The methods on the whole are similar, and only differ from the American system as

regards the transportation of small parcels. In this connection, Mr. A. H. PLANT mentioned the working of express companies in the United States.

“ At the suggestion of Mr. R. L. WEDGWOOD (*North Eastern Railway of England*), an exchange of views took place between Mr. A. H. PLANT, Mr. M. RIEBENACK (*Pennsylvania Railroad*) and Mr. C. W. APPLEYARD (*Central South Africa Government Railways*) on the question of the apportionment of expenses between the accounts of construction and operation, and then on the division of operating charges either between divisions or between the character of service (passengers, freight). It appeared from the data furnished, that there does not seem to be any satisfactory accounting system for dividing expenses between the passenger and freight departments, notwithstanding the great importance of this matter.

“ After an interchange of remarks between different members of the sections, the PRESIDENT submitted to the section the following form of resolution, drawn up by Messrs. A. H. Plant and von Löhr, which was unanimously adopted. ”

The President. — The following are the

#### DRAFT CONCLUSIONS.

“ 1° The organization of the accounting department is so dependent on local and special conditions and requirements of each railway, that it does not admit of any absolute rules of universal application.

“ 2° The centralization of the accounting department in each railroad administration has apparently given excellent results on those railways which have adopted it.

“ 3° Railway budgets should not show by their figures definite and rigidly fixed amounts, but for the greater part of the figures rather a framework, because the conditions of railway work require elasticity between wide limits, according to the circumstances existing at the time.

“ 4° The classification of expenditure and receipts should be as simple as possible, and as similar as possible in different countries.

“ 5° The powers of authorizing and ordering payments should be rigidly defined and as far as possible centralized; the cashier's office should be organized as simply as possible, and in such a manner as to involve the minimum amount of transfers of specie, any reasonable exceptions, of course, being permitted.

“ 6° The organization of station accounts, auditing and distribution of revenue, should be as simple and clear as possible. For this purpose, it is advisable to eliminate the small amounts from the accounts and audit by the use of improved methods, such as the use of express companies, franking stamps, abstract statements, automatic machines, season or contract tickets, cash registers and so forth.

“ 7° Consequently, it is of importance that study and experiment with simplified measures should be earnestly continued.

“ 8° The most extensive use should be made of all modern devices for facilitating bookkeeping and clerical work — for example, typewriters, calculating machines, etc. ”

**Mr. de Richter, reporter for Russia.** (In French.) — I agree on the whole with the conclusions of the section, but I have a few supplementary remarks to offer.

The classification of the headings in the balance sheet showing the final result, in other words, the debit and credit of the undertaking, is to my thinking quite as important as the classification of the budget. This is, moreover, required by the laws of some countries. We should, therefore, alter the wording of clause 4 as follows :

“ The classification of the headings in the balance sheet and of the statement of expenditure and receipts should be as simple as possible, and as similar as possible in different countries. ”

I request also the addition to the same clause of the words : *Therefore it is advisable to incorporate in the programme of a future session a comparative study of the classification adopted on different railways.*

As regards the organization of the accounting properly so called, the conclusions in clauses 2, 6, 7 and 8 only comprise considerations affecting methods of accounting, *i. e.* its centralization and simplification, and do not touch upon the actual essence of the question. This does not seem to me enough. What should be especially pointed out is the main object of accounting which is solely to supply the items of the undertaking's full and true balance sheet. Accountancy may be as centralized and simplified as possible and yet provide insufficient items for preparing the balance sheet. It may even, a far more serious matter, falsify the balance sheet in its entirety, by an arbitrary classification of dealings.

I request, therefore, the interpolation of the following paragraph between clauses 5 and 6 :

*The principal and final aim of accounting on a railroad should be the establishment of a perfect balance sheet of the whole enterprise, exhibiting the true financial status of the corporation and the current working results. The book entries should be supported by appropriate vouchers. Therefore, railway accounts should show the assets and liabilities divided as between capital and working. As regards the receipts, it is especially requisite that their booking should be based on the carriage contracts.*

**Mr. Émile Beurteau, president of the 4<sup>th</sup> section.** (In French.) — We are very sorry that Mr. de Richter arrived too late to take part in the sectional discussion, but I do not think any objection can be raised against a conclusion that limits itself to stating that “ the classification of the headings in the balance sheet should be as simple as possible ”.

As regards the last part of clause 4 suggested by Mr. de Richter, the section thought that it could only express a wish without any dictatorial meaning.

**Mr. de Richter.** (In French.) — Well, it is a simple wish.

**Mr. Émile Heurteau.** (In French.) — In these circumstances, the section has no objection to the addition suggested by Mr. de Richter. Nor have I any objection to raise against the first part of the amendment, to insert between the proposed 5<sup>th</sup> and 6<sup>th</sup> clauses the following paragraph : *The principal and final aim of accounting on a railroad should be the establishment of a perfect balance sheet of the whole enterprise, exhibiting the true financial status of the corporation and the current working results. The book entries should be supported by appropriate vouchers. Therefore, railway accounts should show the assets and liabilities divided as between capital and working.*

As for the last part of Mr. de Richter's amendment requiring that the booking of the receipts should be based on the carriage contracts, that would seem to me to be formulating too precise a rule and consequently is opposed to the first clause of the conclusions which states that " the organization of the accounting department is so dependent on local and special conditions and requirements of each railway, that it does not admit of any absolute rules of universal application. "

**Mr. de Richter.** (In French.) — I am ready to withdraw that part of my amendment.

**Mr. Émile Heurteau.** (In French.) — Since Mr. de Richter is willing to withdraw the second portion of his proposal, we are in perfect harmony.

**The President.** — Is there any objection to that substitution for No. 4?

**Mr. A. H. Plant, reporter.** — Mr. President and gentlemen, I should say not. Speaking for the American railways, I think uniformity in the classification of operating expenses and also the groupings of earnings is a very important item. My opinion is that the general balance sheet should be as clearly and as concisely stated as possible and it should be as nearly uniform as we can get it. I fully concur in the suggestions made by Mr. de Richter.

**The President.** — The following are the

### CONCLUSIONS.

" 1° The organization of the accounting department is so dependent on local and special conditions and requirements of each railway, that it does not admit of any absolute rules of universal application.

" 2° The centralization of the accounting department in each railroad administration, has apparently given excellent results on those railways which have adopted it.

" 3° Railway budgets should not show by their figures definite and rigidly fixed

“ amounts, but for the greater part of the figures rather a framework, because the conditions of railway work require elasticity between wide limits, according to the circumstances existing at the time.

“ 4° The classification of the headings in the balance sheet should be as simple as possible, and as similar as possible in different countries. Therefore, it is advisable to incorporate in the programme of a future session a comparative study of the classification adopted on different railways.

“ 5° The powers of authorizing and ordering payments should be rigidly defined and as far as possible centralized; the cashier's office should be organized as simply as possible and in such a manner as to involve the minimum amount of transfers of specie, any reasonable exceptions, of course, being permitted.

“ 6° The principal and final aim of accounting on a railroad should be the establishment of a perfect balance sheet of the whole enterprise, exhibiting the true financial status of the corporation and the current working results. The book entries should be supported by appropriate vouchers. Therefore, railway accounts should show the assets and liabilities divided as between capital and working.

“ 7° The organization of station accounts, auditing and distribution of revenue, should be as simple and clear as possible. For this purpose, it is advisable to eliminate the small amounts from the accounts and audit by the use of improved methods, such as the use of express companies, franking stamps, abstract statements, automatic machines, season or contract tickets, cash registers and so forth.

“ 8° Consequently it is of importance that study and experiment with simplified measures should be earnestly continued.

“ 9° The most extensive use should be made of all modern devices for facilitating bookkeeping and clerical work — for example, typewriters, calculating machines, etc. ”

— These conclusions were adopted.

## APPENDIX

---

### Letter from J. de Richter, reporter, concerning the conclusions of his report.

---

St. Petersburg, April 20, 1905.

Sir,

Finding it impossible to travel to Washington so as to take part personally in the 4<sup>th</sup> section of the International Railway Congress and to give the necessary explanations to the provisional conclusions of my report, I beg through you to submit to the section the definite conclusions given hereafter. My grounds for so doing rest not only on the data furnished in my own report, but also on the views expressed by my colleagues Messrs. von Löhr and Plant whose remarkable reports I have perused more than once. To demonstrate clearly the harmony of the views expressed by the three reporters, I have added references to Mr. von Löhr's report and conclusions which relate to each of the theses formulated in my final conclusions. That I have not done the same in the case of Mr. Plant's very interesting report, is not because I thought his view differed greatly from my own, but only because I had not time enough to marshal the opinions expressed in Mr. Plant's report, as it does not contain final conclusions like the other reports. This is all the more to be regretted, because Mr. Plant's report touches upon nearly all the subjects dealt with in my report's final conclusions, appended to this letter.

I have the honour to remain, Sir,

your obedient servant,

J. DE RICHTER.

To

*The President of the fourth section.*

## FINAL CONCLUSIONS.

---

### I. — *Organization of administrative and executive authorities (audit and accounts).*

1. — The respective spheres of labour of the administrative and executive authorities in the audit and accounts department should be divided and delimited as strictly as possible, with the object of guaranteeing to each of them the independence necessary for action, and responsibility for such action, whilst coordinating their functions in view of a common end. It is especially important that the power of authorizing and ordering expenditure should be centralized and regulated. (*See also No. 5 of Mr. von Löhr's conclusions.*)

2. — The work of auditing and accounting should be centralized, and devoted to actual requirements, have a practical and well-defined aim, and constitute an organic whole. (*See also No. 2 of Mr. von Löhr's conclusions.*)

3. — A stringent selection of the staff constituting the audit and accounts department should be made, with the object of facilitating their professional evolution, and, whilst augmenting their salaries, of restricting as far as possible the number of the functionaries.

4. — To supplement the work of the men, judicious use should be made of apparatus for registering, calculating, stamping, etc. (*See also No. 8 of Mr. von Löhr's conclusions.*)

### II. — *Cash finance.*

5. — Unproductive accumulation of cash in hand, and the useless transference of specie, should be avoided as far as practicable, by the receiving-offices being charged with the work of expenditure, the free balance of cash being carried forward in a single account. (*See also § 43 of Mr. von Löhr's report.*)

### III. — *Budget finance.*

6. — The classification of the budget of revenue and expenditure should be simplified, by the separation of matters of accounts proper from those comprising the financial and even technical statistics. (*See also No. 4 of Mr. von Löhr's conclusions.*)

7. — The necessary elasticity should be secured to railway budgets by the division of the credit items into "fixed expenditure" and "variable credits" respectively; fluctuations of traffic, and of the consequent expenditure, being duly taken into account. (*See also No. 3 of Mr. von Löhr's conclusions.*)

8. — The administrative authorities should be empowered to cover excesses in the credits for variable expenses by means of the receipts for the corresponding financial period. In order to realize this principle in the State systems, whilst respecting, as far as possible, the general budgetary legislation of the State, it would be advisable :

a) To create a fund called the compensating fund, charged with the provision of means requisite to cover excesses in the credits for variable expenses, the said compensating fund having proportionate allocations made to it as soon as the accounts for each financial year are closed, or

b) To carry to the general State budget only the balance shown in the railway budget scheme, attaching to the said general State budget detailed budgets of the receipts and expenditure of

the system, preserving to the variable portion of each railway budget its character of an anticipatory provision, as distinct from a financial law. (See also §§ 28-31 of Mr. von Löhr's report.)

9. — In order to render as complete as possible the budget of each financial year, the period for the closing of the administrative accounts should be as near as possible to that of drawing up the subsequent budget.

#### IV. — *Audit and accounts.*

10. — In order to simplify the methods of procedure in the department of audit and accounts, it would be advisable not only to centralize them, but also to adapt the procedure to the nature and economic importance of the matters dealt with, and to arrange the drawing up and classifying of documents of accounts in such a manner that in the process of examination by the audit and accounts authorities they simply pass through a series of corrections and successive totalizings, and do not undergo any organic transformation or become the subject of useless repetitions. (See also No. 6 of Mr. von Löhr's conclusions.)

11. — A strict line of demarcation should be drawn between the main body of the transactions and petty matters, the methods of procedure as regards auditing and accounting being simplified in the case of transactions of trifling importance. It would be advisable, further, to distinguish these, taking into account the nature of the operations and the intrinsic value of the accounts. (See also No. 6 of Mr. von Löhr's conclusions.)

12. — The chief object of railway accounts should be the establishment of *an accurate and complete balance-sheet of the undertaking*, embracing at the same time the results of the carrying-out of the budget of revenue and expenditure, based upon vouchers and verified in a manner appropriate to their nature and economic importance. With a view to the attainment of this end, the accounts of the administrative and executive authorities should show *the economic transactions (independently of their liquidation)*, as well as their subsequent liquidation. It is especially desirable that the charging and placing to account of revenue arising from the transport of passengers, luggage, goods, etc., should be made upon the basis of their dispatch by the forwarding station according to the date or period of departure, independently of the period of their transport, arrival, or delivery to the addressee by the receiving station. (See also §§ 62 and 63 of Mr. von Löhr's report.)

13. — Railway accounts, in view of the balance-sheet of the undertaking, should be made up in accordance with the system of double entry, as opposed to cash accounts, which might be kept by the method of single entry. (See also § 25 of Mr. von Löhr's report.)

14. — It would be advisable to separate as far as possible business accounts from cash accounts, and to close the former once a month only (at most), whereas cash accounts should be closed daily, except in certain special and reasonable circumstances. (See also § 70 of Mr. von Löhr's report.)

15. — An antecedent and preventive audit, exercised by an institution absolutely independent of the administrative authorities, should only take place at the time of the preparation of the financial budgets; as regards an antecedent and preventive control of the power of ordering payments, this under the like conditions would have no practical value, since the administrative authorities are not bound to follow the injunctions of the audit department. An antecedent and

prohibitive control would mean nothing less than an organized confusion of the powers of the audit authorities, and should not be allowed under any pretext.

16. — Active control, representing only a complementary measure, would possess no practical value, except on condition of its being duly combined with the control of the vouchers and of the corresponding accounts.

17. — It would be advisable to render as uniform as possible the classification of the contents of the balance-sheet of the undertaking and of the railway budgets of the different countries, and, if it could be arranged, the general technical and statistical data attached to the administrative accounts of each financial year. This question should therefore be placed again upon the programme of the next session of the International Railway Congress. (See also § 37 of Mr. von Löhr's report.)

18. — Methods of simplifying the procedure in the department of audit and accounts should be studied with diligence and ardour, and this question likewise placed again upon the programme at the next session of the Congress. (See also No. 8 of Mr. von Löhr's conclusions.)

4<sup>th</sup> SECTION. — GENERAL.

---

[ 388 .581 ]

QUESTION XV.

---

DURATION AND REGULATION OF WORK

---

*Length of time on duty and working regulations for railway employees  
and labourers.*

**Reporters :**

*America.* — Mr. G. L. POTTER, third vice-president, Baltimore & Ohio Railroad.

*Switzerland.* — Mr. Placide WEISSENBACH, président de la direction générale des chemins de fer fédéraux suisses.

*Other countries.* — Mr. A. PHILIPPE, inspecteur général des lignes Nord belges, membre de la Commission permanente du Congrès.

---

## QUESTION XV.

---

## CONTENTS

---

	Pages.
Sectional discussion . . . . .	1857
Sectional report . . . . .	1868
Discussion at the general meeting. . . . .	1868
Conclusions . . . . .	1870

### PRELIMINARY DOCUMENTS.

Report No. 1 (Switzerland), by Placide WEISSENBACH. (See the *Bulletin* of September, 1904, p. 905.)

Report No. 2 (all countries, except Switzerland and America), by A. PHILIPPE. (See the *Bulletin* of September, 1904, p. 933.)

Report No. 3 (America), by G. L. POTTER. (See the *Bulletin* of November, 1904, p. 1489.)

Vide also the separate issues (in red cover) Nos. 7 and 14.

---

## SECTIONAL DISCUSSION

---

Meeting held on May 8, 1905 (morning).

---

MR. JAMES DOUGLAS, VICE-PRESIDENT, IN THE CHAIR.

**The President.** — Owing to the temporary absence of our president, Mr. Heurteau, it devolves upon me to open this meeting.

Mr. Weissenbach who acted as reporter for Switzerland cannot be present and so I call upon Mr. Faure, our secretary-reporter, to be kind enough to give us a summary of his report.

**Mr. A. Faure, secretary-reporter.** — The report of Mr. Weissenbach gives the history of the labor regulations applying to the employees of the Swiss railroads from the federal law of 1872 to the law of December 19, 1902, relative to transportation. This law, supplemented by regulations and special orders, fixes :

- 1° The duration and hours of work;
- 2° The special rules to be applied to night work, which is figured with an overtime allowance;
- 3° The days of rest, a certain number of which must fall on Sunday, and vacations, the duration of which increases with the age of the employee and the number of years of service;
- 4° The suspension of the freight traffic on Sundays and holidays.

Mr. Weissenbach deduced from his report general rules, which he believes can be established legally, but he stated, at the same time, that the legal regulations should leave enough elasticity to allow of exceptions which the many requirements of the service may necessitate.

The following are the conclusions of Mr. Weissenbach's report :

- 1° The duration of the day's work should be limited to a number of hours as determined by law. In order to determine such hours, it is not possible to adopt an uniform basis applying to all the employees. It is necessary to take into account, not only the different functions which different classes of employees have to exercise, but also the different amount of work employees of the same class have to do according to the locality at which they work (stations with light traffic, busy sections, etc.);

2° The employees are to have a certain number of off days during the year. A certain number of these days are to be joined together into an unbroken leave. Older employees, who have served for many years, are to have, in addition to the fixed number of separate off days, an unbroken leave, the length of which increases as their years of service increase;

3° The legal enactments must be sufficiently elastic to make it possible that the limits fixed by the laws are slightly exceeded where the conditions of the service make it necessary;

4° It is advisable for railway managements to grant of their own free will to the employees who are not protected by the law, off days (specially Sundays off), and also an unbroken leave, the length of which increases as their age and their years of service increase;

5° It does not seem advisable to fix the same limits for all the managements belonging to the International Railway Congress, as the conditions of life in the different countries vary too much.

**The President.** — The conclusions of Mr. Weissenbach's report are of the greatest interest, but it would be better not to discuss the points they raise, until after we have heard the conclusions of all three reports.

I now call upon Mr. Piéron to give us a summary of Mr. Phillippe's report in his absence.

**Mr. Piéron, French Northern Railway.** (In French.) — Gentlemen, I shall first read you the conclusions arrived at by Mr. Philippe, who is prevented by temporary indisposition from being present at this splendid meeting.

Mr. Philippe has prepared a very full report comprising no less than sixty-six replies which come from thirteen different countries.

Legal regulations control the conditions of labor of certain classes of employees in Germany, Austria, France, Italy, Holland, Russia, India and Australia, while in England the law merely confers the control upon the Board of Trade. In England, as in countries having no such laws (as Hungary, Belgium, Denmark, Spain, Luxemburg, Roumania and Servia), the conditions of labor are very much the same as in the countries which have legal regulations. Almost all the legal or private regulations separate employees in to two well defined classes :

1° Station and permanent way employees;

2° Train crews, which again are subdivided into locomotive crew and train staff (conductors and brakemen). Some countries, especially Germany, make in their regulations a distinction between employees of the main lines and employees of light railways or those of secondary importance.

All legal regulations treat of periodical rest, but leave to employers a free hand as to leaves of absence proper or vacations.

Finally, the regulations are, in a general way, all based on an average number of consecutive days. Their arrangements vary in different countries. Mr. Philippe reviews them and points out the necessity of examining as is done in the German instructions, " the conditions of work at the different points so as to determine the equitable time of work for each employee, according to his duties. " And Mr. Philippe quotes the following sentence from the German instructions : " It is impossible

to lay down any definite rules on account of the numerous varieties of work on railways."

I think it is not necessary to say more about this subject, for you have all read the report. I tried to summarize it more completely, but when I found that my paper, though not so long as Mr. Philippe's, was crowded with figures and would only weary you if I read it, I determined that it would be enough if I merely read you Mr. Philippe's own conclusions which run as follows :

1° In the case of the locomotive and train staff, the duration of the period of work and of rest must not be fixed by the individual day. It is advisable to take an *average* calculated on a certain number of consecutive days;

2° The regulations must not generalise too much, must not lay down principles which are too absolute, for there are very many special cases in connection with railway work.

Thus, for instance, rules must not be too strict to make it possible to proportion the duration of the work in a reasonable way to the importance of the actual work which has to be done during that time. In this connection, we may draw attention to the tendency (which we consider illogical) shown in some regulations, in which the intervals of inactivity, in between the work of employees, are reckoned as actual work. Thus in the case of the train staff, the intervening stops between two successive trains are, in those regulations, counted as work at full value, when they are shorter than a specified amount; although during the whole or part of such stops, the employees are actually resting. The result is that the work of some men has to be stopped after a period which actually includes altogether but a small amount of work and when more work could be done without inconvenience. This obstacle to the rational utilization of the employees is evidently the greater, the higher the limit below which such rest is counted as work. It seems to us that logically any regulation of work should not include any clauses in virtue of which periods, however short, in which nothing is done, are counted as work.

For the same reasons, the duration of work of the train staff can be longer than that of the drivers and firemen, who have harder work to do; for the same reason, assistant station masters and pointsmen at large stations, who are always very busy, and similar men at small stations, who have many moments when there is nothing to do, should not be placed on the same footing.

It is, therefore, advisable that the managements, subject eventually to the approval of the authorities, should have discretion to determine the length of the work for each typical case, after going into it on the spot. It would be advisable that the authorities should be empowered as recommended, as we have seen, by the German instructions, "to examine the conditions of work at the different points, so as to determine the equitable time of work of each employee, according to his functions."

They add, that it is "impossible to lay down any definite rules, on account of the numerous varieties of work on railways."

We have been unable to avoid referring, in our conclusions, to these dicta of the German managements; they have struck us by their practical good sense; they show the absolute necessity of not drawing too definite limits in the regulations. What gives them very great value, is the importance of the authority issuing them; it is not unseasonable at this point to remind our readers that the German States work their railways themselves. They have realised that though it is necessary to avoid overwork, it is useless and even harmful to go too far, or to go further than is reasonable, in reducing the duration of the daily work of railway employees.

In the first place, let us repeat, it is in equity necessary that the duration of the work is a direct function of the bodily and mental efforts required; otherwise some of the employees will be favoured, as compared with others. On the other hand, it is not advisable that railway employees, who as a rule are well paid, should, as compared with the workmen in industrial enterprises, be in a position also privileged from the point of view of the importance of the work required.

Regulations which would disregard the principles we have laid down above would be disastrous for railway managements, as the expenses would become increased very materially.

By a reflex effect, the employees and the public would suffer acutely from such useless increase in the working expenses. It will in all probability, in the case of the employees, put a definite stop to any increase of pay, as on the day on which it is enacted that working hours are to be reduced and consequently the number of the men considerably increased, it will become impossible to increase the pay any further.

In the case of the public, it would stop any further improvements in the service, it would stop the building of any new lines, of new stations, the running of new trains; perhaps even fares would have to be raised.

Any governments which would compel railway managements to adopt ill-understood regulations of work, would uselessly increase expenditure, and would thus singularly disregard the interests of both the public and the employees.

**The President.** — We will now have the conclusions of Mr. Potter's report read.

**Mr. G. L. Potter, reporter for America.** — In conclusion, it may be observed that the questions discussed in my report, namely hours of labor, periods of rest, legal holidays and vacations, are touched upon but lightly by the laws of the various sections and States of America, with few exceptions the railroads being affected only by general laws regulating the number of hours constituting a day's work, child labor, employment of women, legal holidays, restriction of labor on Sundays, etc., in a great many of which regulations railroads are excepted, or they are modified to such an extent as will meet the requirements of railroads and affect them in their operation but very little.

The few special laws that are enacted mostly specify the number of hours of labor after which a certain period of rest must be allowed, of which the following is a summary :

1 State provides for . . . . .	8 hours rest after 13 hours work;
1 — — — . . . . .	10 — — — 13 — —
1 — — — . . . . .	8 — — — 15 — —
3 — — — . . . . .	8 — — — 16 — —
1 — — — . . . . .	9 — — — 16 — —
1 — — — . . . . .	10 — — — 16 — —
1 — — — . . . . .	8 — — — 18 — —
1 — — — . . . . .	8 — — — 20 — —
2 — — — . . . . .	8 — — — 24 — —

These laws in most cases conform with the practice established on railroads.

From this it can be concluded that the railroads practically establish their own regulations with regard to these questions, conforming to general laws regulating labor in all industries.

It has already been stated that 50 p. c. of the companies replying have so called agreements with organizations of various classes of employees.

In these agreements, which are primarily schedules of wages, conditions of service are enumerated in more or less minute detail; they are generally signed by the general manager of the railway company and by representatives of the employees, at other times by general officers of their unions, and sometimes by the railway officers only.

Some railways having no agreements issue printed bulletins covering these questions, signed by an operating officer of the railway, and others, while there are no published regulations, are governed by customs which have been crystallized by conferences and precedents, and though unwritten are about as firmly established as the printed and signed agreements.

The above named agreements and tacit understandings primarily define rates of pay, pay for overtime, periods of rest for meals, and usually specify the number of hours of rest allowed after a certain number of hours work.

In some instances when men are under monthly pay, and their work is continuous and unusually arduous, one or two days a month vacation is allowed, and in other cases, one or two weeks a year. These cases, however, are rare, and the matter is usually equalized by a corresponding adjustment of pay, the general principle governing the rate of pay being that an employee is paid for the actual work done.

**The President.** — Gentlemen, I think these three reports ought to open the subject to a very interesting discussion. It would seem that in the Swiss regulations, we have over-regulation; that in the case of the European States generally, there seems to be a certain amount of latitude and the railroad companies do not seem, as a rule, to be restricted by an excessive amount of regulation. In this country, there is substantially no State regulation; that is to say, as given in this short resumé here, some few states of the Union prescribe hours of work and hours of rest, but as a general rule, it is left to the companies to prescribe the rules for their own employees, although in fact the prescription is generally limited by the power of labor unions who are, in the case of the railroad employees, not only very powerful, but include almost all employees within their membership. Therefore, while the State itself interferes to a very slight extent in prescribing the hours of labor and the hours of rest — as I think our American delegates when the discussion opens, will show — the regulation is really in great measure determined by conference between the railroad officials and the heads of the railroad employees organizations; or, if it is not done by direct conference, it is so done as to be in accord with the views of the heads of the railroad organizations.

**Mr. Hugh McLachlan, New South Wales Government Railways.** — There is one matter on which I desire to lay some stress, and it has some bearing on the tenor of your remarks; that is it is somewhat in opposition to the conclusions arrived at by the reporters. I think there is an exaggerated idea as to the interference with the railways in Australia by the local Parliament. As in Germany and Switzerland, our railroads are State railroads, and so it might be imagined that, being government concerns, we have a good deal of interference with regard to our regulations — our regulations, for instance, as to the duration of work — but so far as I can see, we have as a matter of fact less regulation by our Parliament than is the case in many

other countries, than is the case even in America, because we have practically no direct regulation by the Parliament as to the detail or duration of work. The railroads are handled — I am speaking simply of my own State — by a commission. This commission is not political, it is a business commission, and they are practically left to make their own regulations. Of course it is recognized that being State properties, the whole public have a direct interest and a direct concern in the management of the railroads, and I think that is a safeguard to some extent against anything oppressive; or, on the other hand, against anything which would unduly favour the employees. The public recognize that they have to pay the employees, and the conditions, if they are unusually easy, would press upon the public in this way, and the public would have to pay an undue amount on account of that fact.

Referring to the conditions in Germany, the conclusions as we have heard them, state that care must be taken to see that the conditions prescribed are not too favourable to the employees, because then it would punish the general public — that, of course, referring, I take it, to workmen engaged in other than running the trains. To some extent we provide for that in our regulations, which are not Parliamentary regulations, by having a regulation in which it is provided that the rates paid in railway government work shops shall be the average rates of pay that prevail in private establishments; that is to say, that our rates of pay shall be as far as possible regulated by what is paid outside.

There is one conclusion which I should like to see amended, if it is proposed to adopt all these conclusions, and that is the one in which it is stated that the duration of the day's work should be limited to a certain number of hours as determined by law. I think it is the first conclusion. I think if this conference approved or made a conclusion to that effect, that hours of work, the duration of work, should be provided by law, that is the law of the country, it would become somewhat mischievous. Sometimes we do have delegates, parliamentarians, who wish to have everything governed by law, but I think it would be somewhat mischievous if parliaments were to fix the laws governing the employment of employees. The reason I call attention to this is, in the fact that the conclusion adopted by the Congress will naturally carry a considerable amount of weight; if this Congress adopt a resolution to the effect that duration of labor is to be limited by law, and that that is a decision of the Congress, that would have some weight if the question was being discussed, perhaps, in distant parliaments.

We have, as I have said, — although we are a State governed concern — found that we can manage the railroads quite equitably and quite satisfactorily without parliamentary interference, and I think it is far better to allow each railroad as far as possible to work out its own salvation

We have, for instance, a regulation, which prevails apparently in many American States, that the duration of work shall be so many hours, and that work shall not be resumed again without a sufficient interval after the stopping of work; we provide in our own regulations that practically the same thing shall be followed; that is to

say, that no man after a certain period of work shall resume duty without having had an interval of rest of eight hours, and in Australia I think we have been particularly liberal in this respect. There was a resolution adopted by our Parliament, expressing the opinion of the Parliament, that eight hours should be quite sufficient as the number of hours of a day's work. In America you fix, perhaps, ten hours; in Germany I think they fix ten hours as a day's work; and in many places ten hours is considered to be a fair day's work. A resolution of Parliament (that is the only one which has been passed dealing with the number of hours of work which should constitute a fair day's work) was passed that it was the opinion of Parliament that eight hours was a sufficient day's work for the running men. In some respects, however, the commission is outside Parliament in our country. They felt it to be desirable, however, to adopt that resolution, and so our men are engaged for only eight hours continuous work a day.

Conditions generally are very liberal in Australia, and as I have said, we are to some extent influenced by public opinion. Public opinion looks upon eight hours a day as a liberal provision.

We do not have a great deal of Sunday running, and as far as possible we make regulations providing that the men shall work six days a week, that is to say, each man shall get at least one day's rest a week, one day off. We do not say it is Sunday rest, but for social and physical reasons we think one day in seven is a fair thing to allow men who are continuously employed, and generally where work is continuous, we fix eight hours as the legal day's work.

Our railways are State railways and to a large extent we follow the lines laid down and mentioned as existing in Germany on their State lines; but one conclusion has been suggested which I would like to see amended, and that is not to fix a law as to hours of work, not to make a parliamentary law on the subject. It is far better, I think, for such a matter to be left to the good sense of the people and to let it be a matter of agreement between the men and the administration. We have, as in this country, very strong labor unions, and the Commission takes care that conditions shall be favourable to the administration. On the other hand, they take care to see that the demands they make are not extravagant and will not penalize the company by extravagant expenditure.

**Mr C. W. Appleyard**, Central South Africa Government Railways. — I cordially endorse everything Mr. McLachlan has said as to the possible inconvenience it might cause to distant governments if we passed any resolution in this Congress to the effect that a day's work shall be limited to a certain number of hours to be determined by law.

**Mr. C. A. Lambert**, North Eastern Railway, Great Britain. — I think, Sir, that the greatest difficulty in the way of regulation of hours arises in dealing with the train staff. It is comparatively easy to deal with the staff at fixed points, and the subject to which I would like to call some attention is the method of payment of trainmen,

by which they may possibly be induced to go over the railroad so as to keep their own hours within reasonable limits; or sometimes a method may exist which induces men to make time, thereby making money. I think it will probably be agreed that the aspiration of working men is to make money, and in England different systems exist which induce men to make money by reducing their time in going over the road — otherwise a trip system. On some other lines, a system exists by which the more time men make the more money they get. That is a very objectionable system from the railroad company's point of view, and I should be very glad to hear from the representatives of other railways if any system such as the trip system, or a bonus system, is in force.

**The President.** — I would ask Mr. Potter to describe the methods in vogue on some of our western railroads, where pay of the railroad men is regulated by the number of miles run, especially on freight trains.

**Mr. G. L. Potter, reporter.** — On some of the railroads of this country the trainmen are paid by the mile. On many of the roads, however, they are paid by the trip. The rate per trip is made up usually on the basis of a rate per mile. But on other roads there are trip rates which were fixed before the rates per mile became so generally used, and those are still in effect and do not bear any definite relations to the rates per mile.

**Mr. C. W. Appleyard.** — It may be of some interest to Mr. Lambert to learn our experience in South Africa. Originally, when the railroads of the Transvaal were first started, we had a system of paying the running staff by time, and we found that that led to bad running, at least there was not inducement for a man to make up time. After an experience of some months on that, we adopted on some of the sections of the railroad a mileage system; we paid the men according to the mileage they ran. Apparently, the mileage rates adopted were not very carefully calculated, and the amount of money earned by the men gave rise to a certain amount of dissatisfaction among certain other employees. Subsequently, we had meetings between the running staff and the administration, and after much persuasion, the running staff agreed to adopt the trip system. Under that system, a man is paid only his actual schedule time for his trip. We pay our first class drivers half a crown an hour, and we pay them for schedule time only. On a short trip, where a man has to stand by his engine for three or four hours waiting for a return trip, the delay is paid for at a lower rate. Up to the time I had left South Africa, this trip system had worked very well indeed.

**Mr. C. P. Mossop, North Eastern Railway, Great Britain.** — Mr. President, I should like to ask Mr. Potter whether the very big trains which have been hauled in America in recent years, have not created a difficulty in the working of the trip system, or rate of pay per mile; that is to say, whether the men taking charge of bigger loads which are going over the roads, and the time of the trains consequently

being increased does not result in their demanding an increased rate per mile or an increased rate per trip; and if so, whether the American railways have been able to withstand that demand on the part of the men.

**Mr. G. L. Potter.** — We have constantly had demands for increase of wages. When I say constantly, I mean every year or two the committees of the trainmen, the locomotive engineers and firemen, make demands and they have been very persistent, basing them in recent years largely on the increased service required to handle the larger locomotives and larger trains. We, of course, recognize that the labor of the firemen is increased under these changed conditions, but do not concede that the labor of the enginemen is materially increased. But, even taking this position, we have not been able to resist entirely the demands.

**The President.** — **Mr. Piéron**, have you any further remarks?

**Mr. Piéron.** (In French.) — I have been listening very attentively to the remarks recently made on the subject of regulating the hours of labor of railway workmen and employees. I think we can easily come to an agreement, for if I have rightly interpreted the tendency of what has been said, the observations are all founded on the idea that regulation ought to be carried out by the railway companies themselves, due consideration being paid to the diverse and variable circumstances of railways and that more particularly legal intervention, even in the countries where governmental interference is most marked, is thought to be undesirable. I myself read somewhere, perhaps it was in Mr. Weissenbach's report, that the law is so strict that if an employee's time of duty is exceeded, the railway company is liable to be fined even if the hours of labor are exceeded owing to an accident or *force majeure*. I am in the presence of my professional colleagues and we all know that where railways are concerned, *force majeure* may step in irresistibly. It is, therefore, quite unreasonable for penalties to be exacted from anyone who could do nothing to prevent breaking the law.

The inconvenience of regulating the hours of labor by law may be shown by an instance. Suppose work is limited to ten hours, railway companies will be obliged, in order to avoid being convicted, to cut down these hours considerably in practice, so that if delay occurs, and that happens sometimes even on the best managed railways, an employee still escapes exceeding the limits imposed.

You will not have forgotten the very important declaration made by Mr. Philippe. In case you have, I shall take the liberty of reminding you of it. It comes from the German managements who state that "it is impossible to lay down any definite rules on account of the numerous varieties of work on railways."

It seems then that the conclusion arising from the discussion to which you have listened is, on the one hand, that railway companies should not to be tied and bound by legal enactments and, on the other hand, that regulations ought to be kept elastic enough so that they can be adapted to all the many different cases which may arise.

It was with these circumstances in view, that I have taken the liberty of drawing up a scheme of conclusions which I propose to hand over to our officers to be used by them if they think fit.

“ The Congress considering :

“ That it is impossible to establish uniform rules which are applicable to different special cases, because of the many peculiarities of railroad service;

“ That the rules to be applied should vary, not only with the various classes of employees, but also for each class with the greater or less exacting character of work done, which renders it necessary to give them sufficient elasticity to make them adaptable to all possible cases;

“ That, in these circumstances, it is impossible to reconcile the rigidity of the law with the elasticity necessitated by the various arrangements required to meet the needs of the public, the employees and the managements;

“ It is held that it is desirable that the employer should have the greatest latitude to fix, under the control of competent authorities, the regulations of work : 1° to fully take into account the importance of the work to be done, the continuity and intensity of the labor required from the employees of any class; 2° to compute the number of hours according to an average, established through a sufficiently long period, which has been divided into periods of work, separated by suitable rest; 3° to proportion the average duration of work to the nature of the labor and to the degree of responsibility required. ”

**The President.** — Are there any remarks on these conclusions? We can hardly accept the conclusions without discussion.

I do not think that these conclusions specify very clearly as to who are to be the arbiters in the matter. The Government does not lay down any rules or make any laws as to who are really to be the factors in so arriving at a satisfactory conclusion.

**Mr. Hugh McLachlan.** — I think those conclusions as read take away the objection which I spoke of some time ago.

**The President.** — Yes, I think so, in regard to the rigid regulation.

**Mr. Hugh McLachlan.** — Yes Sir.

**The President.** — In actual practice, of course, there must be two parties to every satisfactory conclusion — employer and employee. The employers, of course, have their regular agents through whom the negotiations take place. The employees, on the other hand, can either appear as individuals or as bodies of employees of the same road; or, in the third case, as represented by their unions; and here comes in one of the serious difficulties of the case. In actuality, I do not think there is a railroad that would not prefer simply to treat with committees of its own employees, disregarding altogether the general officers of the union. In practice, however, in this country the unions have considerable power, and, certainly that is

the case in England. Now whether they appear by their union representatives, or whether they appear in person or through committees of employees, they are undoubtedly the power behind the throne in negotiations with employers in regard to all these delicate questions affecting hours of labor.

Is not that the case, Mr. Potter?

**Mr. G. L. Potter, reporter.** — You state it correctly, Mr. President.

**Mr. Piéron.** (In French.) — I do not think any of the interesting remarks you have kindly made militate against the conclusions proposed. In the first place, the position of the unions is not everywhere the same in all the countries concerned; secondly, if you will kindly reconsider my conclusions, the precise terms of which I do not remember, you will find that the interests of the public, the men and the companies are regarded. These are really the three parties concerned in the matter. You have mentioned two, the companies and the employers; there is a third which is likewise deeply interested, namely the public. And you will probably agree with me in thinking that the public should be considered as one of the three contracting parties.

Under these circumstances I think the conclusions I have laid before you will meet with no obstacle or objection on your part.

**The President.** — Are there any other gentlemen who have remarks to make before these conclusions are laid before the section for adoption or rejection?

Shall these conclusions be accepted by this section?

— The conclusions were unanimously adopted.

— The meeting then adjourned.

# DISCUSSION AT THE GENERAL MEETING

---

Meeting held on May 11, 1905 (afternoon).

---

MR. STUYVESANT FISH, PRESIDENT, IN THE CHAIR.

GENERAL SECRETARY : MR. L. WEISSENBRUCH.

ASSOCIATE GENERAL SECRETARY : MR. W. F. ALLEN.

The President read the

## Report of the 4<sup>th</sup> section.

(See the *Daily Journal of the session*, No. 5, p. 90.)

“ The report of Mr. WEISSENBACH gives the history of the labor regulations applying to the employees of the Swiss railroads from the federal law of 1872 to the law of December 19, 1902, relative to transportation. This law, supplemented by regulations and special orders, fixes :

“ 1° The duration and hours of work ;

“ 2° The special rules to be applied to night work, which is figured with an overtime allowance ;

“ 3° The days of rest, a certain number of which must fall on Sunday, and vacations, the duration of which increases with the age of the employee and the number of years of service ;

“ 4° The suspension of the freight traffic on Sundays and holidays.

“ Mr. Weissenbach deduced from his report general rules, which he believes can be established legally, but he stated, at the same time, that the legal regulations should leave enough elasticity to allow of exceptions which the many requirements of the service may necessitate.

“ Mr. PHILIPPE's report, presented to the section by Mr. PIÉRON (*French Northern Railway*), contained many regulations in force in all countries except America and Switzerland.

“ Legal regulations control the conditions of labor of certain classes of employees in Germany, Austria, France, Italy, Holland, Russia, India and Australia, while in England the law merely confers the control upon the Board of Trade. In England, as in countries having no such laws (as Hungary, Belgium; Denmark, Spain, Luxemburg, Roumania and Servia), the conditions of labor are very much the same as in the countries which have legal regulations. Almost all the legal or private regulations separate employees in to two well defined classes :

“ 1° Station and permanent way employees;

“ 2° Train crews, which again are subdivided into locomotive crew and train staff (conductors and brakemen). Some countries, especially Germany, make in their regulations a distinction between employees of the main lines and employees of light railways or those of secondary importance.

“ All legal regulations treat of periodical rest, but leave to employers a free hand as to leaves of absence proper or vacations.

“ Finally, the regulations are, in a general way, all based on an average number of consecutive days. Their arrangements vary in different countries. Mr. Philippe reviews them and points out the necessity of examining as is done in the German instructions, “ the conditions of work at the different points so as to determine the equitable time of work for each employee, according to his duties. ” And Mr. Philippe quotes the following sentence from the German instructions : “ It is impossible to lay down any definite rules on account of the numerous varieties of work on railways. ”

“ From Mr. G. L. POTTER's report, for America, it appears that, with some exceptions, railroads are not regulated except by general laws regulating the work in all industries as to the number of hours constituting a working day, the work of women and children, legal holidays and restriction of labor on Sundays. Only a few States have special laws restricting the number of working hours and regulating the rest to be given to railroad employees.

“ Mr. Weissenbach's report, which contains the regulations made entirely by the government, called forth some observations by Mr. Hugh McLACHLAN (*New South Wales Government Railways*), Mr. C. W. APPLEYARD (*Central South Africa Government Railways*), and Mr. PIERON.

“ These remarks showed the advantage of leaving the regulations to the initiative of the employers, who must consider the various requirements of the service. In countries where the law regulates questions of this nature, it should at least permit very great elasticity, so as to allow not only for exceptions in urgent cases beyond the control of the employer, but also such exceptions as may be necessitated at any time by the daily incidents of railroad operation.

“ On a question put by Mr. C. A. LAMBERT (*North Eastern Railway of England*), Messrs. G. L. POTTER and C. W. APPLEYARD furnished information as to the method

of paying the train staff. In the United States, the train staff is most frequently paid on the mileage system. Another system, the trip system, consists in fixing the wages by trip. The latter is less employed in the United States, but has been adopted on the Central South African railway system.

“ The discussion was closed after this exchange of ideas and the following resolution submitted to the section by Mr. PIÉRON was unanimously adopted. ”

**The President.** — The following are the

### CONCLUSIONS.

“ The Congress considering :

“ That it is impossible to establish uniform rules which are applicable to different special cases because of the many peculiarities of railroad service ;

“ That the rules to be applied should vary, not only with the various classes of employees, but also for each class with the greater or less exacting character of work done, which renders it necessary to give them sufficient elasticity to make them adaptable to all possible cases ;

“ That, in these circumstances, it is impossible to reconcile the rigidity of the law with the elasticity necessitated by the various arrangements required to meet the needs of the public, the employees and the managements ;

“ It is held that it is desirable that the employer should have the greatest latitude to fix, under the control of competent authorities, the regulations of work :

“ 1° To fully take into account the importance of the work to be done, the continuity and intensity of the labor required from the employees of any class ;

“ 2° To compute the number of hours according to an average, established through a sufficiently long period, which has been divided into periods of work, separated by suitable rest ;

“ 3° To proportion the average duration of work to the nature of the labor and to the degree of responsibility required. ”

— These conclusions were adopted by the general meeting.

## MISCELLANEOUS INFORMATION

---

[ 625 .253 ]

### 1. — Handling the air brake in passenger train service <sup>(1)</sup>,

By C. C. FARMER,

WESTINGHOUSE AIR BRAKE COMPANY.

(*Railway Gazette.*)

If the brake on any car or engine in a train is so designed, or in such poor condition, that it will not stop the car or engine in as short a distance as will the brakes on the balance of the train, then the latter must do part of the work of stopping this car or engine. This necessitates heavier brake applications to stop the train within a given distance, reduces the reserve braking power for making shorter stops than at first intended, increases the liability of sliding wheels and the length of all emergency stops, also the tilting of the trucks under cars with the good brakes and causes unnecessary strains in draft gear, all of which make the work of the engineer more difficult.

We cannot at all times, even by the most approved methods of operating the brake valve and maintenance of equipment, prevent a considerable variation in the holding power of the brakes throughout the train; therefore, the type and condition of the draft gear and buffers is worthy of our most careful consideration and attention. The buffer springs should be of sufficient strength to take up any slack there may be in the couplers, thereby reducing to a minimum all unnecessary movements between the cars, and at the same time, must not be so heavy as to necessitate excessive buffs when coupling or materially reduce the slack available for starting a long train.

The best form of draft gear is one which has a limited movement under comparatively low drawbar strains to care for ordinary pulls and buffs. It should also have a gradually increasing resistance, a maximum capacity sufficient to absorb all shocks except those resulting from collisions at a considerable speed, and an absence of sufficient power in the recoil following a heavy buff or pull, to create dangerous and disagreeable shocks and strains in the opposite direction. A noticeable improvement is now being observed in the handling of trains containing modern Pullman cars, all of which are fitted with draft gear containing the features enumerated. As the number of cars so equipped is increased, the result will, of course, be correspondingly greater.

To insure a comparatively uniform distribution of the brake power throughout a train, we should know :

- 1° That the leverage and the remainder of the foundation brakes are correctly designed and installed to deliver the proper force to the brake shoes;
- 2° That the brake cylinders are free from leakage;

---

(<sup>1</sup>) A paper presented to the convention of the Travelling Engineers' Association.

3° That the piston travel is correct and uniformly adjusted;

4° That the strength of the brake rigging including brake beams, is sufficient and the lost motion in the trucks is small enough to prevent an excessive difference between the standing and running piston travel;

5° That the total leverage is low enough to insure ample shoe clearance in brake release, when the piston travel is maintained at the proper amount by an automatic slack adjuster;

6° That in releasing, the reduction of the cylinder pressure, therefore of holding power, is as nearly equal at the front and at the rear of trains as it is possible to make them;

7° That the triple valves and engineer's brake valves are maintained in such condition as will prevent the occurrence of undesired quick action.

The smoothest and safest service braking from speeds of 25 miles per hour and over, is obtained in the two-application stop made by applying the brakes at the beginning of the stop with the maximum force to be employed, thereby obtaining the greatest braking power when the speed is high and the results of the brake application least liable to be noticed by passengers owing to the comparatively low rate of retardation possible, releasing at about 12 to 18 miles per hour and finishing with a moderate application, held on, on long trains, until stopped, unless the locomotive braking power is automatically retained in the final release.

The first brake application must be made at such a distance from the station as would, if held, stop the train short of the desired point. This is to permit of reducing the cylinder pressure, and therefore braking power, when the speed becomes comparatively slow, in order to prevent near the stop an excessive rate of retardation, resulting from high cylinder pressures at slow speeds; also to permit the trucks to partially right themselves and the draft rigging to assume its normal position.

The ideal method for accomplishing the desired reduction of cylinder pressure near the completion of a stop, is obtained with triple valves which permit the engineer to discharge a part of the air from each of the brake cylinders, and yet retain sufficient to complete the stop without making a second application, the results of which are more or less uncertain. Triple valves which accomplish this are in quite general use on electric interurban and elevated roads throughout the country, and are now going into service on steam roads. Until such a time, however, as they come into more general use on steam roads, it will be necessary for us to reproduce this action as closely as possible by employing the two-application method of braking. If the train is not of sufficient length to cause the slack to run out hard when brakes are released at very slow speeds, and the track grade is level or nearly so that the train will stand without brakes, the brakes should be started to release just before the stop is completed in order to reduce the surge to the minimum or wholly eliminate it.

The Westinghouse Air Brake Company's Schedule ET equipment, which they are now furnishing almost exclusively for locomotives, is so designed that the engineer has absolute control, with the automatic brake valve, of the release of pressure from the engine and tender brake cylinders. The locomotive brakes are automatically retained while the train brakes are being released, thereby protecting the draft rigging against heavy jerks which follow the release of brakes on long trains at slow speeds with the ordinary form of engine brake equipment often resulting in rough stops and frequently in trains breaking in two. With the ET equipment, the engine and tender brakes are retained when the automatic brake valve handle is in the release and holding positions (the latter is a new position between running and lap), and are released in running position only, unless the independent brake valve is used.

When making the first release of a two-application stop with this equipment, the brake valve handle should be moved to release position as usual, but as soon as the brake pipe pressure has increased sufficiently to start all brakes to releasing, it should be moved to running position and left there about two seconds, before lapping the valve preparatory to beginning the second application, in order to reduce the locomotive brake cylinder pressure. When making the final release just before the stop is completed, the locomotive brake cylinder pressure should be retained; therefore, the release of train brakes may be started a little earlier than with other types of engine equipment, insuring the righting of trucks before the stop is completed. Final release of train brakes before the stop will be found practicable with trains of considerable length, on account of the locomotive brakes being held.

The straight-air brake installed on many passenger engines, in combination with the automatic, may also be used to advantage in preventing the slack running out hard when a release is made at slow speeds, but when used for this purpose, should be applied moderate before the train brakes are released and handled with sufficient care to prevent shocks to the train.

When a brake release is desired on a train moving at comparatively slow speed and the cylinder pressure on the locomotive is not sufficient to prevent the slack running out hard, the locomotive brake power may be increased with the ET equipment independent brake valve before the release is made, its handle then being returned to the automatic brake valve. The automatic brake valve handle should be placed in release position the usual length of time, namely, until all train brakes are releasing, then moved to the holding position and left there until the brake force on the train has reduced sufficiently to permit the slack to adjust itself, after which by moving the valve handle quickly to running and back to holding position a few times the locomotive braking power will be gradually reduced to any desired amount.

When stops are made on moderate descending grades, sufficient pressure should be retained in the locomotive brake cylinders, by the use of holding position, to prevent the train from starting, as this position keeps all brakes charged. However, if the train brakes are released on ascending grades, the locomotive brakes should be released by the time the stop is completed, so as to prevent the slack from running back harshly. The independent or straight-air brakes may be applied gradually to hold the train.

When stopping on moderate descending grades with the ordinary form of train brake equipment, and the combined automatic and straight-air or the ET equipment on the locomotive, the second application should be held until the stop is completed, after which the engine and tender brakes may be applied with the straight-air or independent brake valve with sufficient force to prevent the train starting. The automatic brakes should then be released and recharged. Heavy applications of the locomotive brakes, with either the independent or straight-air brake valves, should always be made gradually to gather the slack if the train is in motion, otherwise rough handling will result. This is particularly true if the speed is low when the application is made.

We cannot expect the uniformly smooth braking for water and coal stops that is possible at stations and other similar stops, owing to the accuracy required, but heavy shocks to the train can and should be avoided. The roughest stops made at coal chutes and water spouts are when the brakes are released at slow speeds, just before the stopping point is reached, causing the slack to run out hard, and the final reduction is made in the emergency position. One of the worst features of this kind of a stop, is that the brakes on the forward end of the train apply so heavily that the engineer does not feel the slack run is hard, due to the rear brakes applying moderately, and therefore, does not appreciate the seriousness of the results at the rear of the train. He

should encourage advice from the conductor concerning rough handling and the conductor should give it in a gentlemanly manner without awaiting a request.

The brakes on the forward end of a long train will start to release in practically the same length of time with either a low or high excess pressure, but those at the rear end will begin to release much quicker with high excess pressure; therefore, to obtain the most uniform release of brakes throughout a long train and reduce the shocks to a minimum when releasing, a high excess pressure must be had at such times. Returning the brake valve handle from release position to running position before all brakes have commenced to release, increasing the time required for the air to flow to the rear end of the train, is more serious in its effect on the release of brakes than is low excess pressure and is frequently the cause of the slack running out hard, causing heavy jerks and break-in-tvos, and of brakes sticking.

Many passenger trains have been broken in two and given heavy shocks for which the action of the brakes or the manner in which they were operated were held responsible, but which were actually caused by opening the engine throttle before the brakes at the rear end had been given time to release. It should be remembered that a few seconds must elapse before the brakes can begin to release after the brake valve handle is placed in release position and several additional seconds are required for all brake cylinder pressure to entirely discharge. If trains are to be handled smoothly and safely, any error in the period of time elapsing between placing the brake valve handle in release position and opening the throttle, should certainly be on the safe side; therefore, we should instruct the engineers to allow a few seconds to elapse after they think the brakes are released, as their experience and judgment shows they should before opening the throttle.

---

[ 623 .253 ]

## 2. — Diagrams of K triples.

Figs. 1 to 7, pp. 1873 to 1877.

(*Railway and Locomotive Engineering.*)

Mechanical drawings are not sufficiently clear to everybody so that they are always clearly understood. Because of this fact and of the increasing interest taken in the K triple valve, we publish in this number five diagrammatic drawings which illustrate it in all of its operative positions, and we also publish a drawing, figure 7, showing the arrangement of ports and cavities in the slide valves, and in the seat as actually constructed.

A diagrammatic drawing is one in which all parts of the mechanism represented are shown on one plane, without regard for their relative positions as they really are in the mechanism itself, and these drawings shown herewith in figures 2, 3, 4, 5, 6, enable the reader to trace easily the course of the air through the various ports and passages.

As stated in the June number, the general exterior appearance of the K triple is the same as that of all other Westinghouse quick action triples, and although the K triple is perfectly interchangeable with the older type, without alteration in the piping, it is illustrated here in the half tone figure 1, so that it will be all the more readily recognized. About the only difference between this and the older type that can be noted when it is bolted to its reservoir or cylinder, is the symbol K1 or K2, as the case may be, cast on the side of the body, and the projection cast on the top.

The K1 triple goes on where the H1 (F36) triple is used, and the K2 where the H2 (H49) is required.

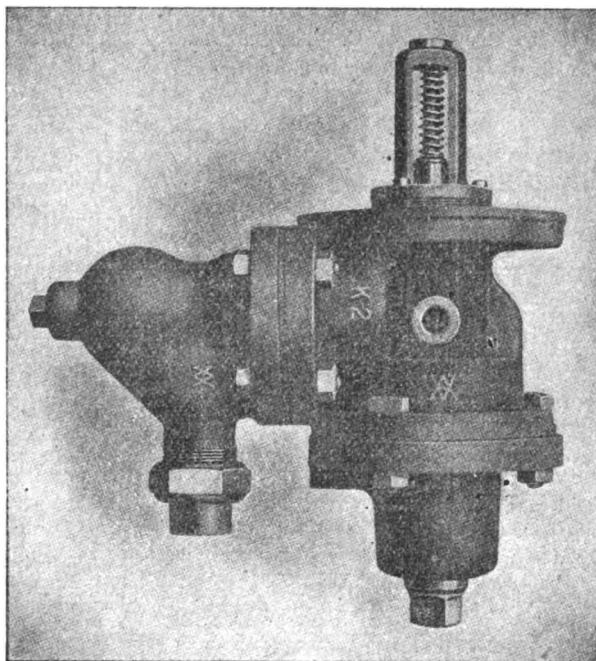


Fig. 1. — Westinghouse "K" triple valve.

The K triple valve has two positions for release of the brakes; one, the full release, shown in figure 2, and the other retarded or we might term it, slow release, as shown in figure 5.

In diagram figure 2, the brake pipe is represented as connecting to the triple at the point BP, so that brake pipe air can flow into passage and chamber *a*, past the check valve into chamber Y, thence upward through passage *y*, in the slide valve seat, through port *j*, in the slide valve, to chamber R and the auxiliary reservoir. It can also, at the same time, flow through passages *e*, *f* and *g* into chamber *h*, thence through feed groove *i* into chamber R and the auxiliary reservoir, charging up the latter to the same pressure contained in the brake pipe.

In figure 2 all parts are represented as being in their normal positions, that is, with the triple valve, the emergency, and the check valves in position to charge the auxiliary, and to release the brake. Port *j* is incorporated in the K2 triple, used on 10-in. equipments, but not in the K1. The K1 triple is used on the smaller equipments, hence does not need this additional feed port.

A gradual reduction in brake pipe pressure, such as is required for a service application, causes the parts to assume the position shown in figure 3, service position. Here it will be seen that ports *i* and *j* are closed, preventing back flow of auxiliary air into the brake pipe; that the exhaust port *p* is closed so as to prevent escape of cylinder air; and that ports Z, in the slide valve, and *r* in the seat, are in register so that air from the auxiliary may flow direct to the brake

cylinder at C. At the same time port *y* in the seat, leading from chamber Y and the brake pipe, and port *o* in the slide valve, are in register, and cavity *v* in the graduating valve spans ports *o* and *q* so that brake pipe air can flow down through port *t*, past the emergency piston, into chamber X, and to the brake cylinder at C. The emergency piston is fitted loosely so that this can be easily done, without undue tendency to move it.

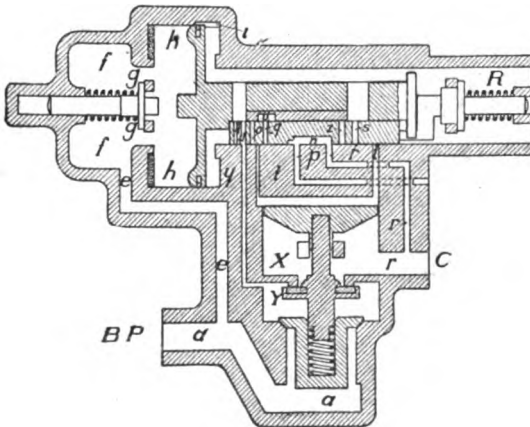


Fig. 2. — Full release and charging position.

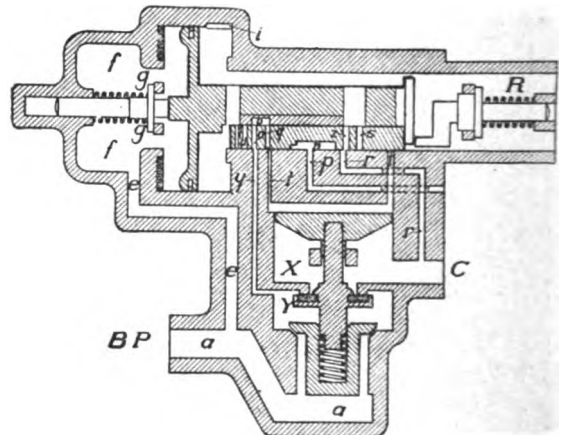


Fig. 3. — Service position.

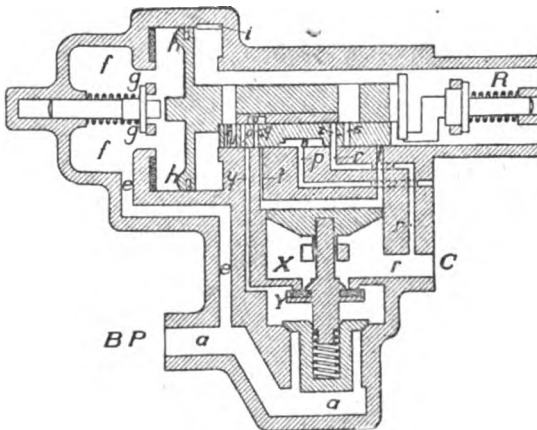


Fig. 4. — Service lap position.

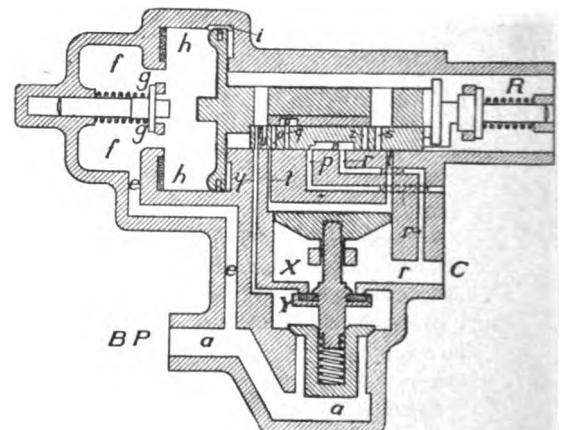


Fig. 5. — Retarded release position.

This figure very clearly shows the manner in which brake pipe air is admitted to the brake cylinder in service applications, and hence why it is that the service reduction is transmitted so quickly to the rear of a long train, applying all brakes evenly and with a uniform pressure.

The service lap position is shown in figure 4. The valves assume this position when the auxiliary pressure reduces to the same amount as that in the brake pipe, or equalize with it, the same as with the ordinary triple.

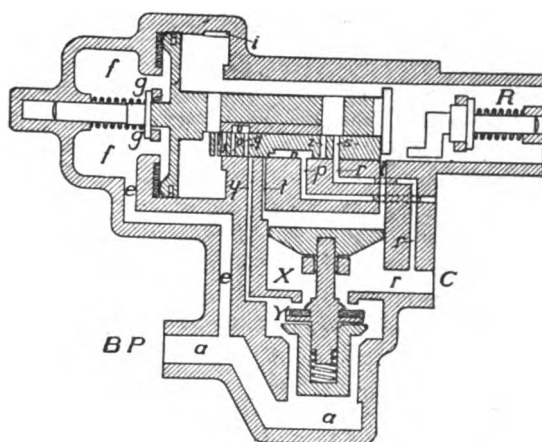
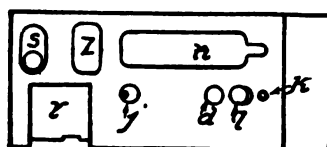


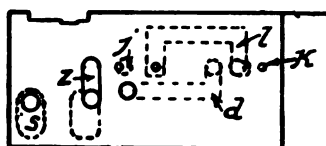
Fig. 6. — Emergency position.



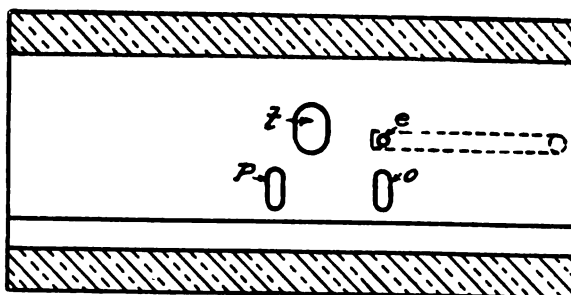
Face view.  
Graduating valve.



Face view.



Top view.  
Slide valve.



Slide valve bush.

Fig. 7. — Arrangement of ports and cavities in "K" triple valve.

In figure 5, the parts are shown in what is known as the retarded release position. The triple piston moves to the right far enough, when the main reservoir air flows rapidly into the brake pipe, to close feed groove *i*, leaving feed port *y* open to the auxiliary, and thus checks the recharging of the auxiliary reservoir; and the exhaust cavity *n* in the slide valve is also moved to the right far enough to reduce its opening considerably, and cause a slow escape of air from the brake cylinder, thus retarding the release of the brake. The spring on the slide valve end of the triple is compressed whenever brake pipe pressure is considerably higher than auxiliary pressure, but as soon as the auxiliary is charged up nearly even with the brake pipe, this spring will return all parts to their normal position, where the exhaust port *m* and the feed groove *i* will be wide open, as in figure 2.

When brakes are released by moving the handle of the brake valve to release position, the main reservoir air flows rapidly into the brake pipe raising the pressure up much higher in the forward end than in the rear of the brake pipe. Hence, the forward brakes are held applied, the rate of recharging the auxiliary is reduced and brake pipe air can flow with greater force toward the rear, and materially hasten the release of those brakes.

This retarding of the release of the forward brakes is what prevents the slack of long trains from running out, and the consequent breaking in two of the train. Closing the feed port *i* brings about a more uniform recharging of the auxiliaries throughout the train. Thus it will be seen that the K triples makes the release of all brakes on a long train much quicker and more certain and uniform than is the case with the present quick action triples on trains of fifty or more cars.

In emergency applications the K triple operates just the same as the present triple, except that a train fully equipped, or partially equipped, with them will get the rear brakes on considerably quicker than with the present triples and also with a little higher pressure. The relative positions of the parts and ports in emergency is shown in figure 6.

[ 628 .144.1 ]

### 3. — Maximum length of rails on the lines of the chief French railways.

(From the *Revue générale des chemins de fer et des tramways*.)

**FRENCH NORTHERN.** — The original iron rail was of the Vignoles type, and 6 metres (19 ft. 8 1/4 in.) long. The steel rail replacing it now weighs 45 kilograms per metre (90.71 lb. per yard). The standard type now used is 12 metres (39 ft. 4 1/2 in.) long. The company proposes to increase this length; some trials of 18 and even of 24 metre (of 59 ft. 1 in. and even of 78 ft. 9 in.) rails have been made, the latter being reserved for steel superstructures and for certain track appliances; but no definite conclusion has yet been arrived at. The engineers are favourably inclined towards the 18 metre (59 ft. 1 in.) rail, but are hostile to the 24 metre (78 ft. 9 in.) rail.

**FRENCH EASTERN.** — The short rail is of the Vignoles type, and is 6 metres (19 ft. 8 1/4 in.) long. It weighs 44.6 kilograms per metre (89.91 lb. per yard). The company has now definitely adopted the 18 metre (59 ft. 1 in.) rail and more than 500 kilometres (310 miles) of track are laid with this rail; some 24 metre (78 ft. 9 in.) rails are used, but only on metal superstructures or in tunnels where the temperature is constant. Special precautions are taken to determine the temperature of the metal itself at the moment when the rail is laid and the gap at the joint is adjusted very carefully. The engineers do not think that the question of adopting a greater length than 18 metres (59 ft. 1 in.) need be considered.

PARIS-LYONS-MEDITERRANEAN. — The short rail is of the Vignoles type, and is 6 metres (19 ft. 8  $\frac{1}{4}$  in.) long. It weighs 47 kilograms per metre (94.75 lb. per yard.) The company has adopted the 12 metre (39 ft. 4  $\frac{1}{2}$  in.) standard which is in use of all its main lines. As an experiment, 360 kilometres (224 miles) of track have been laid with 18 metre (59 ft. 1 in.) rails and 1 kilometre (0.62 mile) with 24 metre (78 ft. 9 in.) rails. The engineers consider the latter length excessive. It is possible that they will adopt 18 metres (59 ft. 1 in.) as standard if results are satisfactory, particularly as regards the size of the gap and premature crushing of the ends of the rails.

MIDI. — The short rail is of the double-headed type, and is 5.5 metres (18 ft.  $\frac{1}{2}$  in.) long. It weighs 38 kilograms per metre (76.60 lb. per yard). In 1880, the standard length was increased to 11 metres (36 ft. 1 in.). In 1903, the company made a trial of 22 metre (72 ft. 2 in.) rails; a section 17 kilometres (10.5 miles) long was laid with them. This trial was looked upon as satisfactory and 22 metre (72 ft. 2 in.) rails are now considered the standard; but owing to contracts previously made rails of this length will only be supplied from 1907 onwards.

ORLEANS. — The short rail is of the double-headed type, and is 5.5 metres (18 ft.  $\frac{1}{2}$  in.) long. It weighs 42.5 kilograms per metre (85.67 lb. per yard) on the main lines and 38 kilograms per metre (76.60 lb. per yard) elsewhere. Some twenty years ago the length was increased to 11 metres (36 ft. 1 in.). Several years ago another advance was made, and only 16.5 metre (54 ft. 2 in.) rails were ordered. On January 1, 1906 there were 900 kilometres (560 miles) of track laid with 16.5 metre (54 ft. 2 in.) rails. The company does not intend to try the 22 metre (72 ft. 2 in.) length.

FRENCH WESTERN. — The short rail is of the double-headed type, and is 6 metres (19 ft. 8  $\frac{1}{4}$  in.) long. It weighs 46.25 kilograms per metre (93.23 lb. per yard) on the main lines and 38.75 kilograms per metre (78.11 lb. per yard) elsewhere. After increasing the length to 12 metres (39 ft. 4  $\frac{1}{2}$  in.), the company has now definitely adopted that of 18 metres (59 ft. 1 in.).

Some experiments were made with 22 metre (72 ft. 2 in.) rails. The results were not favourable and the engineers do not think of adopting this length.

STATE. — The short rail is of the double-headed type, and is 5.5 metre (18 ft.  $\frac{1}{2}$  in.) long. It weighs 40 kilograms per metre (80.63 lb. per yard); for a long time now the 11 metre (36 ft. 1 in.) length has been considered as standard and the greater part of the system is laid with such rails. The length is now being increased. By the end of 1906, 200 kilometres (125 miles) of track will have 16.5 metre (54 ft. 2 in.) rails. Moreover 900 rails 22 metres (72 ft. 2 in.) long have been ordered for use on bridges, but it is not proposed to use them on the ordinary track.

---

[ 621 .14 (09.3 (.42) ]

#### 4. — Road motor-car service.

Figs. 8 to 10, pp. 1881 and 1883.

(*The Railway Magazine.*)

A glance at the map in "Bradshaw" gives to the uninitiated in railway matters an impression of a network through which the trunk lines stand out prominently, as connecting the important

cities of the country by the most direct routes, while smaller towns and villages are brought into communication with these main lines by almost innumerable branches. Nothing is more noticeable in comparing a railway map of England, with that of foreign countries, than this feature — the prevalence of the branch lines.

The logical development of this has been to supplement the network system by means of even more slender filaments than can be supplied by railways. Until now, horse traction has been all that could be found for the purpose, but during the last year or two, self-propelled traction of all kinds has enabled the great railway companies to make use of the roads, which have always been necessarily the basis of their systems, in a manner which has obviated the construction of branch lines, at an expense, which would have rendered them unprofitable.

The early pioneers of our great railways could have had little idea of the great changes in the economic conditions of the country that railway travel was to bring about.

As the population increased in the large towns, which rapidly became the centres of all commerce, and the demand for speedy transit steadily grew, the railways had not only to multiply and accelerate their transport, but to secure that their routes were the most direct available. At the same time, another cause was working in an almost opposite direction. Thousands became dependent every day on the rapid transport of foodstuffs for their daily sustenance, and it is thus that the commerce of the country necessitated the construction of many branch lines, in order to bring the rural districts into touch with great centres such as London, Birmingham and Manchester.

Certain it is that landowners, far from refusing, as they did in the early days, to allow the railways to come near their doors, would, if they now had the opportunity, move heaven and earth to ensure that they should pass through their domains.

Once more the chance is offered them — this time experience has taught them the wisdom of accepting the opportunities given them by the railway companies — and small towns which, by their own doing, or by the nature of the ground, were deprived of railway communication, now find themselves once more linked to civilisation by a system of motor traction.

The London & North Western Railway, although not the actual pioneers of motor-omnibus services, commenced running them as soon as a reliable type of machine was placed on the market.

Early last year the company commenced its first service. This was between Connah's Quay and Flint, on the estuary of the Dee, and Mold, the recognised capital of Flintshire. This route connects the Chester and Denbigh Railway with the Chester and Holyhead line, and enables passengers from the interior of Flintshire and Denbighshire to reach the coast without performing the long journey *via* Chester. The road traversed by the omnibuses leads over the hills, and rises in places to a height of nearly 700 feet above the railway passing through Northop, a prosperous little village three miles from Mold on the one hand, and Flint on the other. Northop residents now have the benefit of twenty-six motor-omnibus services daily to Flint and Mold in connection with trains to and from Chester, Rhyl, Llandudno, Denbigh, and Corwen, made up as follows: five services to and five from Flint, and eight from and eight to Mold, the three extra ones each way between Mold and Northop are performed by the Holywell and Mold motor-bus which runs *via* Northop (see fig. 9).

The distance separating Flint and Mold is 6 miles, and the inhabitants of the former town who formerly had either to travel 24 miles by rail *via* Chester, or trudge 6 weary miles to reach their market town, are now carried there and back in little over an hour for the sum of 1 s. 4 d., while their luggage and parcels are conveyed at very cheap rates.



Fig. 9. — London & North Western Railway motor-omnibus, running between Connah's Quay and Mold.



Fig. 10. — London & North-Western Railway motor-omnibus, running between Holywell station and Holywell town.



How popular this service has been is clearly shown by the fact that more than 70,000 passengers have been carried in one year.

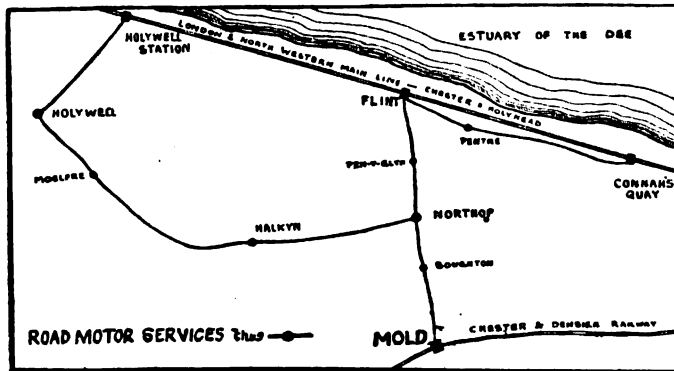


Fig. 9. — London & North Western Railway road motor services in Flintshire.

One of the most enterprising motor-omnibus services in the country, perhaps, is that which is now running between Holywell town and Holywell station, on the London & North Western Railway Company's Chester and Holyhead line. The town of Holywell, perched on the side of Halkyn Mountain, 560 feet above the sea, is more than a mile and a half from the railway, which, on account of the mountainous nature of the country inland, has to hug the coast. The road from the station to the town leads up a narrow valley, passes the famous holy wells (supposed to possess miraculous powers of healing, and, according to tradition, more than 1,200 years old), and reaches Holywell by means of a long hill with a gradient of 1 in 8.

Until, last year horse-drawn conveyances plied between the station and the town, but the enormous strain on the animals, caused by the steep hill, made the omnibuses so unpopular that many passengers preferred to walk, while the rates for the delivery of goods were necessarily very heavy.

All this has been changed by the advent of the motor vehicle, and, to-day, the London & North Western Railway's omnibuses perform thirty trips to and from the town, meeting every train which arrives at the station.

A special type of vehicle (fig. 10) is used, developing 18 indicated horse-power, and carrying 16 passengers, with  $\frac{1}{2}$  ton of luggage. The vehicles negotiate the hill of 1 in 8 with the greatest of ease, and the feelings of the passengers are no longer harrowed as they used to be behind the toiling horses.

In addition to the passenger service, the company now deliver goods by means of a steam lorry, which easily climbs the steep hill into Holywell with 7 tons on its back, forming a striking contrast to the horse which could not draw more than one-fourteenth part of that load into the town. Consequently the railway company is now able to deliver goods at less than half the former cost, and Holywell to-day receives free delivery instead of paying at the rate of 1s. 8d. a ton as heretofore.

Yet another service of motor-omnibuses links Holywell to Mold, 10 miles distant, and enables, the residents of the mining districts of Halkyn and Moelfre to reach their market town quickly and cheaply.

In the neighbourhood of the Metropolis where the cost of land is enormous, the railways are solving the problem of reaching outlying villages by running, frequently, motor-omnibuses. A service of this description is now in force between Watford, on the London & North Western Railway's main line, and Croxley Green, a village 3 miles distant. The inhabitants of this hamlet are provided with an hourly service to Watford, which enables them to reach the Metropolis in fifty-five minutes from their doors.

Such services would seem to admit of great development, but whether in the near future every village will have a regular service of motor-omnibuses calling for intending passengers by the railway is still a doubtful question. For it must not be supposed that, in order to establish a motor-omnibus service, it is only necessary to buy a vehicle, provide petrol and driver, and start it running. The motor-car of to-day is a machine which is very costly both to run and maintain, and, in comparison with the expense involved, can carry but a small complement of passengers. A depot has to be maintained, equipped with a number of spare parts of machinery, ready to replace any that may fail on the vehicle, and the drivers employed must be mechanics thoroughly competent to carry out any repairs necessary. The petrol vehicle, too, is so much in its infancy that it has been found necessary, in order to maintain a reliable service, that a spare omnibus should always stand ready for the road in case of break-downs.

The reader will easily understand, therefore, that it is only in districts where there is a considerable demand for some rapid means of conveyance that the motor-omnibus can at present pay its way, but it is to be hoped that, as time goes on, the same steady progress towards efficiency and economy will be made with this means of transport, as in the case of the locomotive since 1830, and that the self-propelled omnibus will be so developed in the near future as to become far more extensively used than it can be to-day.

Travellers by the road motor-car services provided by the London & North Western Railway can rest assured that special attention is given to see that the powerful brakes with which all the vehicles are fitted, are in thorough working order, a special examination test being made daily.

---

# List of the papers published for the Fifth Session.

ENGLISH EDITIONS (IN RED COVERS).

NUMBER of the pamphlet.	NUMBER of the Question.	TITLE OF THE QUESTION.	CONTENTS.	PRICE.	
				Excluding postage.	Including postage.
1	XX	Brakes for light railways . . . . .	Report, by Mr. Ploeg . . . . .	FR. C. 1 50	FR. O. 1 60
2	V	Boilers, fire-boxes and tubes . . . . .	Addenda, by the same.		
3	XVI	Decimal system. . . . .	Report, by Mr. Ed. Sauvage . . . . .	3 "	3 15
4	XIX	Light railway shops . . . . .	— by Mr. J.-L. Wilkinson . . . . .	1 50	1 60
5	XV	The twenty-four hours day. . . . .	— by Mr. Terzi . . . . .	1 50	1 60
6	XIII	Organisation. . . . .	— by Messrs. Scolari and Rocca. . . . .	1 50	1 60
7	X	Station working . . . . .	2 <sup>nd</sup> report (for English speaking countries), by Mr. Harrison. . . . .	1 50	1 60
8	XI	Signals . . . . .	2 <sup>nd</sup> report on parts A and B (for English speaking countries), by Mr. Turner . . . . .	2 25	2 40
9	I	Strengthening of permanent way in view of increased speed of trains.	2 <sup>nd</sup> report (for English speaking countries), by Mr. Thompson . . . . .	2 25	2 40
10	VI	Express locomotives . . . . .	1 <sup>st</sup> note, by Mr. Raynar Wilson. . . . .		
11	II	Places in permanent way requiring special attention.	2 <sup>nd</sup> report (for English speaking countries), by Mr. William Hunt . . . . .	3 "	3 20
12	XIII	Organisation. . . . .	Addenda by the same.		
13	VII	Rolling stock for express trains . . . . .	Report, by Mr. Aspinall. . . . .	7 50	7 90
14	III	Junctions. . . . .	— by Mr. Sabouret . . . . .	1 50	1 60
15	...	The history, organisation and results of the International Railway Congress.	1 <sup>st</sup> report (for non-English speaking countries), by Mr. Duca . . . . .	9 "	9 40
16	IX	Acceleration of transport of merchandis . . . . .	Report, by Mr. C.-A. Park. . . . .	2 "	2 10
17	XII	Cartage and delivery. . . . .	— by Mr. Zanotta . . . . .	3 "	3 15
			Note, by Mr. A. Dubois. . . . .	2 50	2 65
18	XI (See also N° 8)	Signals . . . . .	Report, by Mr. H. Lambert . . . . .	1 50	1 60
			Report, by Mr. H. Twelvetees . . . . .	1 50	1 60
			1 <sup>st</sup> note, by the Belgian State Railways Administration. . . . .		
			2 <sup>nd</sup> note, by the Western Railway of France Administration. . . . .		
			1 <sup>st</sup> Report for non-English speaking countries), by Mr. Motte. . . . .	3 75	3 95
			2 <sup>nd</sup> note, by the Mediterranean Railway Company (Italy). . . . .		
			3 <sup>rd</sup> note, by Mr. Theo. N. Ely. . . . .		
			4 <sup>th</sup> — by the American Railway Association (Messrs. A.-W. Sullivan and F.-A. Delano). . . . .		
			5 <sup>th</sup> note, by Mr. Robert Pitcairn. . . . .		
			6 <sup>th</sup> — by Mr. A.-T. Dice. . . . .	1 50	1 60
19	XVII-A	Light feeder lines (contributive traffic). . . . .	Report, by Mr. De Backer. . . . .	1 50	1 60
20	XIV	Settlement of disputes . . . . .	— by Mr. De Peri. . . . .	1 50	1 60
21	XVIII	The working of light railways by leasing companies.	— by Mr. de Burlet . . . . .	3 75	3 95
22	IV	Construction and tests of metallic bridges . . . . .	Note, by Mr. W.-M. Acworth. . . . .	4 50	4 75
23	X	Station working. (Methods of accelerating the shunting of trucks.)	Report, by Mr. Max Edler von Leber. . . . .		
		Station working. (Employment of mechanical and electrical appliances in shunting.)	1 <sup>st</sup> report on Part A (for non-English speaking countries), by Mr. J. de Richter . . . . .	6 "	6 30
			1 <sup>st</sup> report on Part B (for non-English speaking countries), by Messrs. Eug. Sartiaux and A. von Boschan. . . . .		
			1 <sup>st</sup> note, on Part B, by Mr. Ast . . . . .		
			2 <sup>nd</sup> — by the Administration of the "Kaiser Ferdinand Nordbahn". . . . .		
24	...	Railway progress in the Dominion of Canada . . . . .	Memorandum, by the Hon. Sir Charles Tupper. . . . .	1 50	1 60
25	I (See also N° 9)	Strengthening of permanent way in view of increased speed of trains.	Report, by Mr. Ast (first part) . . . . .	2 25	2 40
26	XVII-B	Relaxation of normal requirements for light railways.	Report, by Messrs. Humphreys-Owen and P.-W. Meik. . . . .	3 "	3 15
			1 <sup>st</sup> note, by Mr. E.-A. Ziffer. . . . .		
			2 <sup>nd</sup> — — — — —		
			3 <sup>rd</sup> — by the Hon. Thomas C. Farrer. . . . .		
27	VIII	Electric traction . . . . .	Report, by Mr. Auvert . . . . .	6 50	6 80
			1 <sup>st</sup> note, by the Western of France Railway. . . . .		
			2 <sup>nd</sup> — by the Northern of France Railway. . . . .		
			3 <sup>rd</sup> — by Mr. Ernest Gerard . . . . .		
			Note, by Mr. Chas. J. Owens. . . . .	1 50	1 55
28	XIV (See also N° 20)	Settlement of disputes . . . . .	Report, by Mr. Ast second part). . . . .	3 50	3 70
29	I (See also N° 9 and 25)	Strengthening of permanent way in view of increased speed of trains.			
30	A	Technical information on the breaking of steel rails. . . . .	Report, by Mr. Bricks . . . . .	1 50	60
31	B	— on the current cost of metallic compared with wooden sleepers.	— by Mr. Kowalski . . . . .	3 "	
32	C	Technical information on the life of wooden sleepers of different kinds, not pickled or pickled according to various processes.	— by Mr. V. Herzenstein . . . . .	7 "	
33	D	Technical information on locomotive crank axles.			
34	E	— on locomotive fire-boxes . . . . .	As the information collected on this question was very incomplete, it was not dealt with.		
35	F	— on locomotive boilers . . . . .	Report, by Mr. Hodeige . . . . .	6 "	6 30
36	G	— on the lubrication of rolling stock. . . . .	— by Mr. Belleruche . . . . .	3 50	3 70
37	H	Technical information on shunting engines and on the movement of the staff in different countries.	— by Mr. Hubert . . . . .	3 50	3 70
38	I and J		As the information collected on these questions was very incomplete, it was not dealt with.		

N. B. — The numbering of the pamphlets (see first col.) issued in French and English is not the same. The English editions are in red covers and the French editions in brown covers.

CONTENTS.	PAGES.	NUMBERS OF PLATES AND FIGURES.	NUMBERS of the DECIMAL CLASSIFICATION.
I. — <b>Governmental regulation</b> in the United States, by Logan G. McPHERSON . . . . .	1761	...	385 .14 (.73)
II. — <b>Buffers</b> during shunting operations and during the braking of long trains, by J. DOYEN. . . . .	1771	Fig. 1, p. 1775.	625 .216
III. — <b>Locomotive tests</b> , by Dr. W. F. M. Goss . . . . .	1779	Figs. 1 to 25, pp. 1784 to 1815.	621 .131.3
IV. — <b>The telephone in railroad service</b> , by H. L. BURDICK and W. T. SAUNDERS . . . . .	1817	...	656 .254
V. — <b>PROCEEDINGS OF THE SEVENTH SESSION</b> (4 <sup>th</sup> section, general):			
Question XIV : <b>Book-keeping</b> . Sectional discussion. Report of the 4 <sup>th</sup> section. Discussion at the general meeting. Conclusions . . . . .	1823	...	656 .237
Appendix : Letter from J. de Richter, reporter, concerning the conclusions of his report . . . . .	1851	...	656 .237
Question XV : <b>Duration and regulation of work</b> . Sectional discussion. Report of the 4 <sup>th</sup> section. Discussion at the general meeting. Conclusions . . . . .	1855	...	385 .581
VI. — <b>MISCELLANEOUS INFORMATION</b> :			
1. <b>Handling the air brake</b> in passenger train service, by C. C. FARMER . . . . .	1871	...	625 .253
2. <b>Diagrams of K triples</b> . . . . .	1874	Figs. 1 to 7, pp. 1875 to 1877.	625 .253
3. <b>Maximum length of rails</b> on the lines of the chief French railways . . . . .	1878	...	625 .144.1
4. <b>Road motor-car service</b> . . . . .	1879	Figs. 8 to 10, pp. 1881 and 1883.	621 .14 (.09.3 (.42)
VII. — <b>MONTHLY BIBLIOGRAPHY OF RAILWAYS</b> :			
I. <b>Bibliography of books</b> . . . . .	119	...	016 .385. (02
II. — of periodicals . . . . .	122	...	016 .385. (05
VIII. — <b>CONTENTS</b> of the 11 <sup>th</sup> year of the English edition (20 <sup>th</sup> year of the French edition) . . . . .	I-XI	...	...
IX. — <b>ANALYTICAL table</b> of articles arranged according to the decimal classification . . . . .	1-12	...	...

MONTHLY BIBLIOGRAPHY OF RAILWAYS <sup>(1)</sup>

PUBLISHED UNDER THE SUPERVISION OF

L. WEISSENBRUCH

Secretary General of the Permanent Commission of the International Railway Congress.

[ 016 .385. (02) ]

## I. — BIBLIOGRAPHY OF BOOKS

(July, 1906.)

## In French.

- 1906 62. (01)  
**ARAGON** (Ernest), ingénieur des arts et manufactures.  
**Résistance des matériaux appliquée aux constructions.**  
 Méthodes pratiques par le calcul et la statique graphique.  
 Tome deuxième.  
 Paris, Dunod & Pinat, 1 volume in-16 (190 × 125), 752 pages,  
 756 figures. (Prix : 15 francs.)

- 1906 669. (02)  
**ASSOCIATION DES ANNUAIRES INDUSTRIELS.**  
**Annuaire de la métallurgie et des mines.**  
 Bruxelles, M. Weissenbruch, imprimeur du roi, 1<sup>re</sup> édition,  
 in-8°, 950 pages. (Prix : 12.50 francs.)

- 1906 621 .132  
**CARLIER** (J. G.), répétiteur du cours d'exploitation des  
 chemins de fer à l'université de Liège.  
**Les locomotives à grande vitesse.**  
 Paris, Ch. Béranger, 1 volume in-8°, 44 figures dans le texte.  
 (Prix : 3 francs.)

- 1906 621 .9 (01)  
**CODRON** (C.), ingénieur, professeur à l'Institut industriel  
 du Nord.  
**Expériences sur le travail des machines-outils pour les  
 métaux. 2<sup>e</sup> fascicule : Forage.**  
 Paris, Dunod & Pinat, libraires-éditeurs. In-4°, 552 pages,  
 1,027 figures. (Prix : 25 francs.)

- 1906 385 .582  
**GRILLET** (L.), inspecteur du travail dans l'industrie.  
**Hygiène du travail dans les établissements industriels et  
 commerciaux.**  
 Paris, imprimerie Gauthier-Villars et librairie Masson & C<sup>ie</sup>.  
 In-8° (190 × 120), 192 pages, 9 figures. (Prix : 2.50 francs.)

- 1906 385 .581  
**GRILLET** (L.), inspecteur du travail dans l'industrie.  
**La réglementation du travail dans les établissements  
 industriels.**  
 Saint-Amand (Cher), imprimerie Bussière; Paris, librairie  
 Gauthier-Villars; librairie Masson & C<sup>ie</sup>. In-16, 172 pages.

- 1906 62. (03)  
**OFFINGER** (H.).  
**Dictionnaires technologiques de poche en quatre langues**  
 (allemand, anglais, français, italien).  
 Stuttgart, J. B. Metzler, éditeur. 4 volumes in-32, 264 +  
 359 + 342 + 250 pages. (Prix : 2.80, 4.20, 4.40, 3.20 marcs.)

## In German.

- 1906 625 .11 (02)  
**BLUM, von BORRIES und BARKHAUSEN.**  
**Die Eisenbahn-Technik der Gegenwart. II. Band. Der Eisen-  
 bahnbau der Gegenwart. 1. Abschn. Linienführung und  
 Bahngestaltung.** Bearb. von SCHUBERT (Paul) und BLUM (A.).  
 Wiesbaden, C. W. Kreidel. 2. Aufl. Lex., in-8°, ix-144 Seiten  
 mit 121 Abbildungen im Texte und 3 lithographierte-Tafeln.  
 (Preis : 5.40 Mark.)

<sup>(1)</sup> The numbers placed over the title of each book are those of the decimal classification proposed by the Railway Congress conjointly with the Office Bibliographique International, of Brussels. (See "Bibliographical Decimal Classification as applied to Railway Science," by L. WEISSENBRUCH, in the number for November, 1897, of the *Bulletin of the International Railway Congress*, p. 1509.)

**N. B. — The Monthly Bibliography is printed on one side only so that it may be cut up into slips and pasted on labels for catalogues and indexes.**



**1906** **621 .137.1 (02)**  
**BRAUSER** (Paul), Obering., und **SPENNRATH** (Jos.). Dir.  
**Der praktische Maschinenwärter.** Anleitung für Maschinenisten und Heizer, sowie zum Unterricht in techn. Schulen.  
 Berlin, M. Krayn. 5. Auflage, in-8°, iv-117 Seiten mit 38 Abbildungen. (Preis : 1.50 Mark.)

**1906** **625 .25 (02)**  
**BROSIOUS** (Max.), Eisenbahn-Bauinspektor.  
**Die Maschine und der Wagen, sowie die neuesten Bremsvorrichtungen :** Bremse von HEBERLEIN, Vakuumbremsen von HARDY und KÖRTING, Luftdruckbremsen von WESTINGHOUSE und SCHLEIFER.  
 Wiesbaden, J. F. Bergmann. In-8°, xvi-619 Seiten, 567 Holzschn., 10 Tafeln und 1 Abbildung des Westinghouse-Bremsventils mit drehbarem Schieber. (Preis : 6.40 Mark.)

**1906** **624 .2**  
**DAUB** (H.).  
**Vereinfachte Ermittlung der gleichförmig belasteten gewalzten I-, C- und Z-Träger bei Hochbauten.**  
 Leipzig und Wien, Franz Deuticke. 6 Seiten und 3 Tafeln. (Preis : 2.50 Mark.)

**1906** **621 .335**  
**DIE BROWN, BOVERI & Co AKTIENGESELLSCHAFT.**  
**Simplon-Lokomotiven.**  
 Zurich; Berlin, Julius Springer. Lex., in-8°, 23 Seiten mit Abbildungen. (Preis : 1.20 Mark.)

**1906** **621 .116. (02)**  
**MENGBIER** (W.).  
**Handbuch über die Dampfkesselfabrikation im Deutschen Reiche mit Berücksichtigung der Zubehörteile zum Dampfkesselbau und Dampfkesselbetriebe.**  
 Leipzig, H. A. Ludwig Degener. 120 Seiten und 81 Figuren. Preis : 3 Mark.)

**1906** **621 .7 (.73)**  
**REISSNER** (H.). Prof. Dr. Ing., Konstruktionsingenieur an der Königl. Technischen Hochschule zu Berlin.  
**Amerikanische Eisenbahnwerkstätten.** Bericht.  
 Berlin, R. Dietze. Folio, mit zahlreichen Figuren und Tabellen im Text und 11 Illustrationstafeln. (Preis : 12 Mark.)

**1906** **624 .2 (01)**  
**SCHMIEDEL** (Ottom.), Oberingen.  
**Die Statik der statisch bestimmten Brückenträger.** Elementares Lehrbuch zum Gebrauch für Schüler techn. Unterrichtsanstalten, für Techniker und Ingenieure in der Praxis und zum Selbststudium angeh. Ingenieure.  
 Berlin, W. & S. Loewenthal. Lex., in-8°, iv-158 Seiten mit 202 Figuren. (Preis : 9 Mark.)

**In English.**

**1906** **389**  
**ANTHONY** (E.).  
**An enquiry into and an explanation of decimal coinage and the metric system of weights and measures.**  
 London, Routledge. 3<sup>rd</sup> edition, 4<sup>vo</sup>. (Price : 2s. 6d.)

**1905** **388 (.73)**  
**ARNOLD** (Bion-Joseph).  
**Report on the engineering and operating features of the Chicago transportation problem ;** submitted to the Committee on local transportation of the Chicago City Council, Chicago, November 1902.  
 New York, Mc Graw Publishing Co. 8<sup>vo</sup>, 310 pages, 11 diagrams, 14 fold. plates. (Price : \$5.)

**1906** **62. (02)**  
**FERRIS** (Chas. E.).  
**Manual for engineers.**  
 Knoxville, University of Tennessee. Sixth edition. (Price : 50 cents.)



## II. — BIBLIOGRAPHY OF PERIODICALS

(June, 1906.)

## In French.

**Annales des mines. (Paris.)**

**1906** **625** .2 (01)  
 Annales des mines, avril, p. 448.

MARIÉ (G.). — Les dénivellements de la voie et les oscillations du matériel des chemins de fer. (14,000 mots & fig.)

**Annales des ponts et chaussées. (Paris.)**

**1906** **351** .812.1 (.45)  
 Annales des ponts et chaussées, avril, p. 365.

Loi concernant l'exploitation des chemins de fer par l'État en Italie. (4,000 mots.)

**1906** **313** .385 (.71)  
 Annales des ponts et chaussées, avril, p. 377.

Résultats généraux de l'exploitation des chemins de fer du Canada pendant les exercices 1903-1904 et 1902-1903. (8 tableaux.)

**1906** **313** .385 (.469)  
 Annales des ponts et chaussées, avril, p. 381.

Résultats généraux de l'exploitation des chemins de fer portugais en 1903 et 1902. (3 tableaux.)

**1906** **313** .385 (.498)  
 Annales des ponts et chaussées, avril, p. 383.

Résultats généraux de l'exploitation des chemins de fer de l'État roumain pendant les années 1903 et 1902. (5 tableaux.)

**Annales techniques. (Paris.)**

**1906** **621** .132.3 & **621** .134.4  
 Annales techniques, n° 1, 1<sup>er</sup> juin, p. 1.

BOUNIN (R.). — Les locomotives compound du Great Western Railway. (900 mots & fig.)

**Annales des travaux publics de Belgique. (Bruxelles.)**

**1906** **624** .6 (01)  
 Annales des travaux publics de Belgique, juin, p. 493.

DESCANS (L.). — Arcs à deux rotules et arcs encastres. (40,000 mots & fig.)

**1906** **625** .5 (.494)  
 Annales des travaux publics de Belgique, juin, p. 709.

Nouveaux funiculaires aériens. (1,200 mots.)

**Bulletin du Congrès international des chemins de fer. (Bruxelles.)**

**1906** **624** . (01)  
 Bulletin du Congrès des chemins de fer, n° 6, juin, p. 489.

MARRIOTT (William). — Consolidation et entretien des anciens ponts en fer (mémoire et discussion). (19,700 mots, 3 tableaux & fig.)

**1906** **621** .133. (01)  
 Bulletin du Congrès des chemins de fer, n° 6, juin, p. 538.

BUSSE (O.). — Note sur la puissance de vaporisation des chaudières de locomotives. (750 mots.)

**1906** **624** .63 & **721** .9  
 Bulletin du Congrès des chemins de fer, n° 6, juin, p. 541.

Béton armé (question IV, 7<sup>e</sup> session). Discussion. (11,300 mots.)

**1906** **621** .134  
 Bulletin du Congrès des chemins de fer, n° 6, juin, p. 569.

Machines à grande puissance (question V, 7<sup>e</sup> session). Discussion. (45,000 mots.)

**1906** **621** .132.8  
 Bulletin du Congrès des chemins de fer, n° 6, juin, p. 654.

Moteur à pétrole pour la traction des voitures de chemins de fer. (1,700 mots & fig.)

**1906** **625** .253  
 Bulletin du Congrès des chemins de fer, n° 6, juin, p. 659.

La nouvelle triple valve Westinghouse type K. (2,400 mots & fig.)

**1906** **62** . (01) (06)  
 Bulletin du Congrès des chemins de fer, n° 6, juin, p. 663.

Association internationale pour l'essai des matériaux. (Congrès de Bruxelles en 1906.) (600 mots.)

**1906** **016** .385. (02)  
 Bulletin du Congrès des chemins de fer, n° 6, juin, p. 55.

Bibliographie mensuelle des chemins de fer. — Livres. (19 fiches.)

**1906** **016** .385. (05)  
 Bulletin du Congrès des chemins de fer, n° 6, juin, p. 57.

Bibliographie mensuelle des chemins de fer. — Périodiques. (147 fiches.)



**Bulletin des transports internationaux  
par chemins de fer. (Bern.)**

**1906** **625 .1** (09 .494)  
Bulletin des transports intern. par ch. de fer, n° 6, juin, p. 199.  
L'ouverture du tunnel du Simplon. (3,000 mots.)

**Éclairage électrique. (Paris.)**

**1906** **625 .13**  
Éclairage électrique, n° 22, 2 juin, p. 334.  
Sur la composition de l'air du chemin de fer Métropolitain de New-York. (3,000 mots.)

**Génie civil. (Paris.)**

**1906** **621 .33 & 625 .4**  
Génie civil, n° 1246, 28 avril, p. 444.  
DUMAS (A.). — Le chemin de fer électrique souterrain Nord-Sud de Paris. (4,500 mots & fig.)

**1906** **625 .234**  
Génie civil, n° 1248, 12 mai, p. 23.

GUÉRIN (H.). — Chauffage des trains par la vapeur et l'eau combinées, ou par la vapeur détendue. (2,400 mots & fig.)

**1906** **625 .232**  
Génie civil, n° 1249, 19 mai, p. 40.

MARRE (F.). — Les nouvelles voitures de 3<sup>e</sup> classe de la Compagnie des chemins de fer du Midi. (600 mots, 1 tableau & fig.)

**1906** **621 .33 (.44)**  
Génie civil, n° 1251, 2 juin, p. 65.

Traction électrique à 2,400 volts sur la ligne de Saint-Georges-de-Commiers à la Mure (Isère). (2,000 mots & fig.)

**Journal des transports. (Paris.)**

**1906** **621 .132.8, 621 .33 & 656 .27**  
Journal des transports, n° 23, 9 juin, p. 265.

Automotrices sur rails. (4,000 mots.)

**1906** **385 .15 (.42)**  
Journal des transports, n° 23, 9 juin, p. 271.

La nationalisation des chemins de fer en Angleterre. (1,000 mots.)

**1906** **385 .113 (.44)**  
Journal des transports, n° 24, 16 juin, p. 277.

Les résultats de 1905. Le réseau du Nord. (2,000 mots & 3 tableaux.)

**Nouvelles annales de la construction. (Paris.)**

**1906** **625 .142.4**  
Nouvelles annales de la construction, n° 618, juin, p. 90.

Traverses en ciment armé et traverses mixtes pour voies de chemins de fer. (1,200 mots, 1 tableau & fig.)

**Revue politique et parlementaire. (Paris.)**

**1906** **385 .15 (.493)**  
Revue politique et parlementaire, n° 144, juin, p. 504.  
PESCHAUD (M.). — Les chemins de fer de l'État belge. (10,000 mots.)

**In German.**

**Annalen für Gewerbe und Bauwesen. (Berlin.)**

**1906** **621 .138.2**  
Annalen für Gewerbe und Bauw., N° 695, 1. Juni, p. 201.

HARPRECHT. — Mechanische Lokomotivbekohlungsanlagen mit besonderer Berücksichtigung der Bekohlungsanlage Grunewald und über die Staubabsaugungsanlage dasselbst. (3,300 Wörter & Fig.)

**1906** **625 .236**  
Annalen für Gewerbe und Bauw., N° 695, 1. Juni, p. 214.

GUILLERY. — Staubsauger. (2,900 Wörter, 1 Tabelle & Fig.)

**Beton und Eisen. (Berlin.)**

**1906** **624 .7**  
Beton und Eisen, Heft VI, p. 140.

ZIPKES (S.). — Eisenbetonbrücken mit versenkter Fahrbahn. (1,600 Wörter, 2 Tabellen & Fig.)

**1906** **625 .142.4**  
Beton und Eisen, Heft VI, p. 144.

MONTENEGRO (O. N. di). — Die Betoneisen-Schwellen. (600 Wörter & Fig.)

**Oesterreichische Eisenbahn-Zeitung. (Wien.)**

**1906** **656 .235**  
Oesterreichische Eisenbahn-Zeitung, N° 18, 1. Juni, p. 161.

Die Fortentwicklung des vereinfachten Abfertigungsverfahrens. (1,700 Wörter.)

**Elektrische Bahnen und Betriebe.  
Zeitschrift für Verkehrs- und Transportwesen.  
(München.)**

**1906** **621 .33**  
Elektrische Bahnen und Betriebe, Heft 17, 13. Juni, p. 313.

HOTOPF. — Die elektrischen Bahnanlagen der Filderbahn. (3,300 Wörter & Fig.)

**Zeitschrift für Kleinbahnen. (Berlin.)**

**1906** **621 .33**  
Zeitschrift für Kleinbahnen, Heft 6, Juni, p. 341.

Die Einführung des elektrischen Betriebes auf der New York Central-Eisenbahn. (3,600 Wörter & Fig.)



1906 313 : 621 .33 (.42)

Zeitschrift für Kleinbahnen, Heft 6, Juni, p. 348.

Elektrische Bahnen in Grossbritannien. (300 Wörter & Tabellen.)

Zeitschrift des österreichischen Ingenieur- und Architekten-Vereines. (Wien.)

1906 624 .63

Zeit. des öst. Ingen.- und Archit.-Ver., Nr 22, 1. Juni, p. 333.

MELAN (J.). — Die Beton-Eisen-Brücke Chauderon-Montbenon in Lausanne. (3,200 Wörter, 3 Tabellen & Fig.)

1906 621 .132.8

Zeit. des öst. Ingen.- und Archit.-Ver., Nr 23, 8. Juni, p. 346.

KRIŽKO (J.). — Benzinelektrische Selbstfahrer im Eisenbahnbetriebe. (3,500 Wörter & Fig.)

Zeitschrift des Vereines deutscher Ingenieure. (Berlin.)

1906 621 .132.8

Zeit. des Vereines deutscher Ingen., Nr 22, 2. Juni, p. 860.

HELLER (A.). — Der Eisenbahnmotorwagen der Maschinenfabrik Esslingen. (1,000 Wörter, 2 Tabellen & Fig.)

1906 621 .134.3

Zeit. des Vereines deutscher Ingen., Nr 22, 2. Juni, p. 870.

METZELTIN. — Lokomotiven mit Ventilsteuerung. (1,200 Wörter & Fig.)

1906 621 .14

Zeit. des Vereines deutscher Ingen., Nr 23, 9. Juni, p. 907.

HELLER (A.). — Personen- und Güterbeförderung mit schweren Motorwagen. (1,600 Wörter, 3 Tabellen & Fig.)

Zeitung des Vereines deutscher Eisenbahnverwaltungen. (Berlin.)

1906 656 .25 (01 (.43)

Zeitung des Vereines, Nr 42, 2. Juni, p. 669.

Nr 43, 9. — p. 685.

CAUER (W.). — Zur deutschen Signalordnung. (6,500 Wörter.)

1906 625 .11

Zeitung des Vereines, Nr 42, 2. Juni, p. 672.

Die Eisenbahn Alaska-Sibirien. (3,500 Wörter.)

1906 385 .51

Zeitung des Vereines, Nr 44, 13. Juni, p. 705.

HERTZER (W.). — Die Haftung der Eisenbahn für ihr Personal nach dem Bürgerlichen Gesetzbuch. (4,000 Wörter.)

## In English.

American Engineer and Railroad Journal. (New York.)

1906 621 .132.3

American Engineer & R. Journal, No. 6, June, p. 203.

Prairie type passenger locomotive with Walschaert valve gear. (500 words, 1 table & fig.)

1906 621 .132.1

American Engineer & R. Journal, No. 6, June, p. 217.

Simple four-cylinder passenger locomotive with superheater. (1,200 words & fig.) (See *Bulletin of the Railway Congress*, No. 11, November 1905.)

1906 621 .133.5

American Engineer & R. Journal, No. 6, June, p. 228.

American engineer tests on locomotive draft appliances. (2,400 words & fig.)

American Machinist. (New York.)

1906 621 .13 (01

American Machinist, No. 24, June 30, p. 762.

BASFORD (G. M.). — The motive-power officer. (4,500 words.)

Bulletin of the International Railway Congress. (Brussels.)

1906 625 .233 & 621 .32

Bulletin of the Railway Congress, No. 6, June, p. 865.

L'HOEST (G.). — The electric lighting of railway trains on the L'Hoest-Pieper system. (4,800 words & fig.)

1906 621 .134.3

Bulletin of the Railway Congress, No. 6, June, p. 879.

VAUGHAN (H. H.). — The use of superheated steam on locomotives. (13,500 words, 11 tables & fig.)

1906 313 .385

Bulletin of the Railway Congress, No. 6, June, p. 907.

GOODCHILD (A. A.). — Railroad statistics. (4,700 words & 2 tables.)

1906 621 .33 & 656 .222.1

Bulletin of the Railway Congress, No. 6, June, p. 917.

The Berlin-Zossen high-speed tests of 1901. (7,000 words, tables & fig.)

1906 625 .143

Bulletin of the Railway Congress, No. 6, June, p. 947.

Rails for lines with fast trains (question II, 7<sup>th</sup> session). Discussion. (30,200 words & fig.)



**1906** **625 .143**  
Bulletin of the Railway Congress, No. 6, June, p. 1014.

DUDLEY (P. H.). — Rails for lines with fast trains (question II, 7<sup>th</sup> session). Addenda to the report No. 3. (Appendix to the discussion.) (4,800 words & fig.)

**1906** **625 .151**  
Bulletin of the Railway Congress, No. 6, June, p. 1027.

Improved rail crossings (frogs) (question III, 7<sup>th</sup> session). Discussion. (1,500 words.)

**1906** **625 .253**  
Bulletin of the Railway Congress, No. 6, June, p. 1034.

The new Westinghouse "K" triple valve. (2,000 words & fig.)

**1906** **625 .216**  
Bulletin of the Railway Congress, No. 6, June, p. 1038.

Automatic couplings. (400 words.)

**1906** **385 .517.1**  
Bulletin of the Railway Congress, No. 6, June, p. 1038.

Lancashire & Yorkshire Railway Superannuation Fund. (350 words.)

**1906** **016 .385. (02)**  
Bulletin of the Railway Congress, No. 6, June, p. 55.

Monthly bibliography of railways. — Books. (19 labels.)

**1906** **016 .385. (05)**  
Bulletin of the Railway Congress, No. 6, June, p. 57.

Monthly bibliography of railways. — Periodicals. (147 labels.)

**Engineer. (London.)**

**1906** **624 .1**  
Engineer, No. 2631, June 1, p. 547.

The new railway bridge at Newcastle. (2,000 words & fig.)

**1906** **621 .132.3**  
Engineer, No. 2632, June 8, p. 573.

ROUS-MARTEN (C.). — Latest express engines—South Eastern & Chatham Railway. (1,800 words & fig.)

**1906** **624 .52**  
Engineer, No. 2632, June 8, p. 575.

New suspension bridge at New York. (2,200 words, 2 tables & fig.)

**Engineering. (London.)**

**1906** **656 .256.3 & 625 .4**  
Engineering, No. 2109, June 1, p. 718.

Automatic signalling on the underground railways of London. (4,500 words & fig.)

**1906** **625 .212**  
Engineering, No. 2109, June 1, p. 738.

EYERMANN (P.). — Solid rolled-steel car-wheels and tyres. (5,200 words, 1 table & fig.)

**1906** **621 .132.3**  
Engineering, No. 2110, June 8, p. 757.

Fairlie locomotive for the Bolivian Railways. (700 words & fig.)

**1906** **62. (01 & 669 .1**  
Engineering, No. 2110, June 8, p. 770.

BANNISTER (C. O.). — The relation between type of fracture and microstructure of steel test pieces. (2,500 words, tables & fig.)

**Engineering Magazine. (London.)**

**1906** **385. (01 (.91)**  
Engineering Magazine, June, p. 329.

BENNETT (L. E.). — Transportation in the Philippines. (2,700 words & fig.)

**Engineering News. (New York.)**

**1906** **725 .31**  
Engineering News, No. 21, May 24, p. 567.

The Pennsylvania R. R. passenger station in New York city. (1,000 words & fig.)

**1906** **624 .63**  
Engineering News, No. 21, May 24, p. 570.

LUTEN (D. B.). — The reinforced concrete beam culvert : an inefficient structure. (2,000 words & fig.)

**1906** **625 .241 & 625 .246**  
Engineering News, No. 21, May 24, p. 572.

Steel flat cars for specially heavy loads. (2,000 words, 1 table & fig.)

**1906** **621 .331**  
Engineering News, No. 22, May 31, p. 591.

The Pennsylvania R. R. extension to New York and Long Island : structural details of Long Island power station. (4,000 words & fig.)

**1906** **625 .13**  
Engineering News, No. 22, May 31, p. 611.

Report on the defects of the Brooklyn tunnels of the New York Rapid Transit Railway. (2,300 words.)

**1906** **656 .254**  
Engineering News, No. 22, May 31, p. 615.

A train order signal system for electric railways. (1,400 words & fig.)



**1906** 625 .144.4  
Engineering News, No. 22, May 31, p. 616.  
BLACKIE (G. F.). — Curving rails by power : Nashville, Chattanooga & St. Louis Railway. (2,000 words.)

**Great Western Railway Magazine.** (London.)

**1906** 621 .331  
Great Western Railway Magazine, No. 6, June, p. 110.  
SMITH (R. T.). — Electric supply for traction, power, and lighting in the G. W. R. London district. (1,300 words & fig.)

**Page's Weekly.** (London.)

**1906** 621 .12 & 656 .211.7  
Page's Weekly, No. 91, June 8, p. 1272.  
The Dover-Ostend turbine steamship "Princesse Elisabeth". (800 words, 2 tables & fig.) (*S. Bulletin of the Railway Congress*, No. 5, May 1906.)

**1906** 625 .143.3  
Page's Weekly, No. 92, June 15, p. 1316.  
MOYLE (G.). — Roaring rails. A mysterious development. (1,400 words & fig.)

**Railroad Gazette.** (New York.)

**1906** 656 .221  
Railroad Gazette, No. 21, May 25, p. 521.  
What stops a moving train. (2,700 words.)

**1906** 725 .31  
Railroad Gazette, No. 21, May 25, p. 522.  
The Pennsylvania Railroad's extension to New York and Long Island. (1,200 words & fig.)

**1906** 621 .13 & 621 .33  
Railroad Gazette, No. 23, June 8, p. 563.  
The passing (?) of the steam locomotive. (1,400 words.)

**1906** 625 .244  
Railroad Gazette, No. 23, June 8, p. 565.  
Baltimore & Ohio refrigerator car. (400 words & fig.)

**1906** 625 .243 & 625 .246  
Railroad Gazette, No. 23, June 8, p. 568.  
Standard 80,000-lb. box car for the Rock Island-Frisco system. (600 words & fig.)

**1906** 625 .24 (01  
Railroad Gazette, No. 23, June 8, p. 572.  
SYMONS (W. E.). — The 50-ton box car as a standard in railroad equipment. (2,600 words.)

**1906** 656 .256.2  
Railroad Gazette, No. 23, June 8, p. 574.  
All-electric interlocking at council bluffs. (1,500 words & fig.)

**1906** 621 .13 (01  
Railroad Gazette, No. 23, June 8, p. 581.  
BASFORD (G. M.). — The motive power officer. (4,000 words.)

**1906** 656 .211.7  
Railroad Gazette, No. 23, June 8, p. 593.  
DAVIDSON (R. C.) & BOARDMAN (B.). — Car ferry lines of American railroads. (2,000 words, 1 table & fig.)

**1906** 621 .132.8  
Railroad Gazette, No. 23, June 8, p. 598.  
A new steam rail motor car. (700 words & fig.)

**Railway Age.** (Chicago.)

**1906** 625 .13  
Railway Age, No. 1564, June 1, p. 887.  
Plan for a tunnel under the English channel. (1,300 words & fig.)

**1906** 625 .13 & 625 .4  
Railway Age, No. 1564, June 1, p. 897.  
Ventilation of the Interborough Subway, New York. (5,000 words.)

**Railway and Engineering Review.** (Chicago.)

**1906** 725 .31  
Railway and Engineering Review, No. 21, May 26, p. 375.  
Pennsylvania R. R. extension to New York and Long Island. (1,200 words & fig.)

**Railway Gazette.** (London.)

**1906** 621 .138.1  
Railway Gazette, No. 20, June 1, p. 801.  
The Great Western Railway's new London locomotive depot. (1,500 words, 1 table & fig.)

**1906** 625 .143.4  
Railway Gazette, No. 21, June 8, p. 841.  
CONRADI (J. F.). — Rail joints. (600 words, 1 table & fig.)

**1906** 725 .31  
Railway Gazette, No. 21, June 8, p. 852.  
The Pennsylvania Railroad's extension to New York and Long Island. (1,200 words & fig.)

**Railway Magazine.** (London.)

**1906** 656 .222.1  
Railway Magazine, No. 108, June, p. 458.  
ROUS-MARTEN (C.). — British locomotive practice and performance. (3,500 words & fig.)



**Railway News. (London.)**

**1906** 625 .245

Railway News, No. 2216, June 23, p. 1123.

The North Eastern Railway new fish, fruit, and milk vans. (700 words & fig.)

**Railway Times. (London.)**

**1906** 656 .211.4

Railway Times, No. 23, June 9, p. 734.

New station for the Pennsylvania Railway at New York. (1,300 words & fig.)

**1906** 621 .33 (.42)

Railway Times, No. 24, June 16, p. 765.

Electrification of the Hammersmith & City Railway. (4,000 words & fig.)

**Street Railway Journal. (New York.)**

**1906** 313 : 625 .62 (.43)

Street Railway Journal, No. 22, June 2, p. 844.

MATTERSDORF (W). — Influences determining street railway traffic in German cities. (2,400 words & fig.)

**1906** 621 .332

Street Railway Journal, No. 23, June 9, p. 896.

SMITH (W. N.). — The power transmission line and third-rail system of the Long Island Railroad. (6,500 words & fig.)

**1906** 656 .256.3

Street Railway Journal, No. 23, June 9, p. 908.

Block-signal system of the New York Central electric zone. (2,700 words & fig.)

**1906** 625 .232

Street Railway Journal, No. 24, June 16, p. 951.

Buffet and limited service instituted between Indianapolis and Ft. Wayne by the Ft. Wayne & Wabash Valley traction Company. (600 words & fig.)

**1906** 621 .337

Street Railway Journal, No. 24, June 16, p. 953.

A new automatic counting block signal. (900 words & fig.)

**Tramway & Railway World. (London.)**

**1906** 621 .335

Tramway & Railway World, June, p. 541.

A petrol-electric rail motor car. (700 words, 1 table & fig.)

**In Italian.**

**Ingegneria ferroviaria. (Roma.)**

**1906** 385. (06.4)

Ingegneria ferroviaria, n° 10, 16 maggio, p. 150.

La Mostra delle ferrovie dello Stato. (2,000 parole & fig.)

**1906** 621 .132.8

Ingegneria ferroviaria, n° 10, 16 maggio, p. 154.

Vetture automotrici a vapore in esperimento sulle linee Venete. (2,200 parole & fig.)

**1906** 621 .138

Ingegneria ferroviaria, n° 11, 1° giugno, p. 170.

LUZZATTO (V.). — Impianti americani per ricambio degli assi montati delle locomotive. (1,800 parole & fig.)

**1906** 625 .253

Ingegneria ferroviaria, n° 12, 16 giugno, p. 183.

MELE (V.). — Sul freno Westinghouse ad azione rapida. (2,700 parole, 1 tavole & fig.)

**Rivista generale delle ferrovie e dei lavori pubblici. (Firenze.)**

**1906** 625 .143.4

Rivista generale delle ferrovie, n° 25, 17 giugno, p. 389.

Nuovo tipo di compresse con ferma-dadi per giunzioni di rotaie. (400 parole & fig.)

**In Spanish.**

**Revista de obras públicas. (Madrid.)**

**1906** 621 .33 (.46)

Revista de obras públicas, n° 1603, 14 de junio, p. 291.

PLAYA (J.). — Sustitución de la tracción de vapor por la eléctrica en el ferrocarril de Sarrià a Barcelona. (3,300 palabras & fig.)

**In Dutch.**

**Ingenieur. ('s Gravenhage.)**

**1906** 385. (06.119)

Ingenieur, n° 23, 9 Juni, p. 413.

DUFOUR (L. H. N.). — Mededeelingen omtrent het verhandelde op het spoorweg-congres te Washington. (17,000 woorden & fig.)



# BIBLIOGRAPHIA UNIVERSALIS

COOPERATIVE PUBLICATION OF THE OFFICE BIBLIOGRAPHIQUE INTERNATIONAL, OF BRUSSELS

## MONTHLY BIBLIOGRAPHY OF RAILWAYS <sup>(1)</sup>

PUBLISHED UNDER THE SUPERVISION OF

L. WEISSENBRUCH

Secretary General of the Permanent Commission of the International Railway Congress.

[ 016 .385. (02) ]

### I. — BIBLIOGRAPHY OF BOOKS

(August, 1906.)

#### In French.

1905 62. (01)  
**CLAISE** (Benjamin), ingénieur, et **DUBOIS** (Armand),  
géomètre.

Cours théorique et pratique de résistance des matériaux à  
l'usage des ingénieurs, architectes, constructeurs, etc.

Bruxelles, imprimerie J. Dubois & C<sup>e</sup>. In-8°, 199 pages,  
figures. (Prix : 5 francs.)

1906 62. (03)  
**GRAFFIGNY** (Henry DE), ingénieur civil.

Dictionnaire des termes techniques employés dans les  
sciences et dans l'industrie. Recueil de 25,000 mots tech-  
niques avec leurs différentes significations.

Paris, Dunod & Pinat. In-8°, 840 pages. (Prix : 12 fr. 50 c.)

1906 621 .14  
**LE GRAND.**

Les omnibus automobiles. Conseils pratiques sur l'orga-  
nisation des transports publics.

Paris, librairie Bernard Tignol. In-8°, 16 figures. (Prix :  
1 fr. 50 c.)

1906 385 .581  
**MAURICE** (A.), docteur en droit.

La réglementation de la durée du travail des employés de  
chemins de fer. (Thèse.)

Laval, imprimerie Barnéoud & C<sup>e</sup>; Paris, librairie Giard  
& Brière. In-8°, 152 pages.

1906 656 .23 (.44)

**MÉNIEUX** (E. DE).

Tarifs comparés des chemins de fer français.

Paris, imprimerie et librairie Bernard. In-4°, 129 pages.  
(Prix : 25 francs.)

1906 625 .61 (08 (.493)

**SOCIÉTÉ NATIONALE DES CHEMINS DE FER VICI-  
NAUX.**

Rapport présenté par le conseil d'administration. 21<sup>e</sup> exer-  
cice social, 1905.

Bruxelles, imprimerie J. B. Schaumans. In-4°, 141 pages,  
diagramme et carte.

#### In German.

1906 625 .616

**LAYRIZ** (Otfried), Oberstleutnant Z. D.

Der mechanische Zug mittelst Dampf-Strassenlokomotive.  
Seine Verwendbarkeit für die Armee im Kriege und im  
Frieden.

Berlin, Ernst Siegfried Mittler & Sohn. 29 Abbildungen und  
6 Tafeln.

(1) The numbers placed over the title of each book are those of the decimal classification proposed by the Railway Congress conjointly with the Office Bibliographique International, of Brussels. (See "Bibliographical Decimal Classification as applied to Railway Science," by L. WEISSENBRUCH, in the number for November, 1897, of the *Bulletin of the International Railway Congress*, p. 1500.)

**N. B. —** The Monthly Bibliography is printed on one side only so that it may be cut  
up into slips and pasted on labels for catalogues and indexes.



**In English.**

- 906 **385.** (08 (.54) & **313** .385 (.54)  
**Administration Report on the Railways in India for the calendar year 1905.**  
 Simla, Printed at the Government Central Printing Office. 2-4<sup>to</sup>, 235 pages with a map. (Price : 2 rupees.)
- 
- 906 **385 .3** & **656** .235  
**DEPARTMENT OF JUSTICE OF THE UNITED STATES.**  
**Departure from published rates by the Atchison, Topeka & Santa Fe Railway Company, etc.;** letter from the attorney-general, transmitting copies of the correspondence between the president and the attorney-general and others; with copy of the opinion of judge PHILLIPS in the contempt proceedings begun on account of said departure.  
 Washington, D. C., U. S. Office of the superintendent of documents. 8<sup>vo</sup>, 224 pages.
- 
- 906 **656** .212  
**DROEGE (J. A.),** division superintendent, New York, New Haven & Hartford Railway.  
**Yards and terminals and their operation.**  
 New York, the *Railroad Gazette*. Cloth (6 × 9 inches), 85 pages, 31 figures. (Price : \$2.50.)
- 
- 906 **625** .114  
**HUDSON (J. Rogers).**  
**Tables for calculating the cubic contents of excavations and embankments.**  
 New York, J. Wiley & Sons. Fourth edition, 8<sup>vo</sup>, cl., 133 pages, diagrams. (Price : \$1.)
- 
- 906 **62.** (02  
**KINEALY (J. H.).**  
**Mechanical draft : a practical handbook for engineers and draftsmen.**  
 New York, Spon & Chamberlain. Cl. 16<sup>mo</sup>, 14 + 142 pages, with 27 original tables and 13 half-tone pls. (Price : \$2.)
- 
- 906 **385** .51  
**MILES (J. E.).**  
**The railroads, their employees and the public : a discourse upon the rights, duties and obligations of each toward the other.**  
 Plymouth, Mass., Memorial Press. 8<sup>vo</sup>, cl., 199 pages. (Price : \$1.)

- 1906 **621** .132.8  
**NORRIS (W.).**  
**Modern steam road wagons.**  
 New York, Longmans, Green & Co. O. cl., 14 + 174 pages. il. (Price : \$2.25.)
- 
- 1906 **385.** (02  
**Poor's railroad manual, appendix and diary;** containing Poor's ready reference bond list, dividends paid, annual meetings, etc.  
 Special edition of February, 1906.
- 
- 1906 **313 : 656** .28 (.42)  
**Railway accidents.** Returns and reports of inspectors on accidents reported to the Board of Trade during October to December 1905. Part. 2. Reports on accidents.  
 London, King & Son. (Price : 1s.)
- 
- 1906 **621** .33 (06.4 (.73)  
**Report of the Electric Railway Test Commission to the President (Hon. D. R. Francis) of the Louisiana Purchase Exposition.**  
 New York, McGraw Publishing Co. Cl., 14 + 621 pages, il. pers. diagrams. (Price : \$6.)
- 
- 1905 **385 .3** & **656** .235  
**UNITED STATES INTERSTATE COMMERCE COMMISSION.**  
 Letter from the chairman of the Interstate Commerce Commission, transmitting record, testimony, and opinion of the Commission in the **Matter of alleged unlawful rates and practices in the transportation of coal and mine supplies by the Atchison, Topeka & Santa Fe Railroad Company.**  
 Washington, D. C., U. S. Office of the superintendent of documents. 8<sup>vo</sup>, 183 pages, 6 fold. tab.
- 
- 1905 **313** .385 (.73)  
**WOODWARD (James T.).**  
**A statistical analysis of the operations of the Pennsylvania Railroad Company, years ending December 31, 1899-1904, inclusive.**  
 New York, O. C. Lewis & Co. Cl., 8-57 pages. (Price : \$1.)
- 
- In Italian.**
- 
- 1906 **625** .13  
**BLADEGO (G. B.).** Ingegnere.  
**I grandi trafori Alpini Fréjus, San Gottardo, Sempione ed altre gallerie.**  
 Milano, Hoepli. In due volumi con atlante di 30 tavole. (Prezzo : 45 lire.)



## II. — BIBLIOGRAPHY OF PERIODICALS

(July, 1906.)

## In French.

**Annales des ponts et chaussées. (Paris.)****1906** 624.5 & 624.6  
Annales des ponts et chaussées, 1<sup>er</sup> trimestre, p. 26.**LEBERT (E.).** — Ponts suspendus et ponts en arc.  
300 mots & fig.)**1906** 624. (01  
Annales des ponts et chaussées, 1<sup>er</sup> trimestre, p. 198.**BARAU.** — Note sur les résultats des épreuves des  
liers métalliques de la ligne de Quillan à Rivesaltes.  
600 mots, tableaux & fig.)**1906** 721.4 (01  
Annales des ponts et chaussées, 1<sup>er</sup> trimestre, p. 247.**DAVIDESCO.** — Examen critique des formules em-  
ployées pour déterminer l'épaisseur à la clef des voûtes  
maçonnerie. Formule nouvelle. (1,200 mots & fig.)**1906** 313.385 (.52)  
Annales des ponts et chaussées, mai, p. 471.Résultats de l'exploitation des chemins de fer japo-  
nais pendant les exercices 1902-1903 et 1901-1902.  
tableaux.)**1906** 313.385 (.54)  
Annales des ponts et chaussées, mai, p. 475.Résultats généraux de l'exploitation des chemins de  
fer de l'Inde anglaise pendant les années 1904 et 1903.  
tableaux.)**Bulletin annoté des chemins de fer  
en exploitation. (Paris.)****1906** 613  
Bulletin annoté des chemins de fer, mai-juin, p. 36.Hygiène, propreté, désinfection, voitures à voyageurs,  
installations des gares, locaux. Circulaire ministérielle du  
mars 1906. (1,300 mots.)**Bulletin du Congrès international  
des chemins de fer. (Bruxelles.)****1906** 313.385  
Bulletin du Congrès des chemins de fer, n° 7, juillet, p. 665.**DODCHILD (A. A.).** — La statistique dans les  
chemins de fer. (5,400 mots & 2 tableaux.)**1906**

Bulletin du Congrès des chemins de fer, n° 7, juillet, p. 677.

**BUSSE (O.).** — Note sur l'étanchéité des cadres de  
foyers. (900 mots.)**1906**

Bulletin du Congrès des chemins de fer, n° 7, juillet, p. 680.

**X...** — Note sur la consolidation des attaches de rails  
au moyen des garnitures métalliques, système J. Thiollier.  
(2,900 mots, 6 tableaux & fig.)**1906**

Bulletin du Congrès des chemins de fer, n° 7, juillet, p. 691.

La deuxième conférence de revision relative à la  
convention internationale sur le transport de mar-  
chandises par chemins de fer. (8,000 mots.)**1906**

Bulletin du Congrès des chemins de fer, n° 7, juillet, p. 705.

**Équipe double et multiple** (question VI, 7<sup>e</sup> session).  
Discussion. (18,400 mots.)**1906**

Bulletin du Congrès des chemins de fer, n° 7, juillet, p. 743.

**Attelages automatiques** (question VII, 7<sup>e</sup> session).  
Discussion. (25,200 mots & fig.)**1906**

Bulletin du Congrès des chemins de fer, n° 7, juillet, p. 795.

**PETTIGREW (W. F.).** — Attelages automatiques  
(question VII, 7<sup>e</sup> session). Supplément à l'exposé n° 1  
(Angleterre). Annexe à la discussion. (1,300 mots & fig.)**1906**

Bulletin du Congrès des chemins de fer, n° 7, juillet, p. 803.

**Attelages automatiques** (question VII, 7<sup>e</sup> session). Note  
sur l'appareil d'attelage automatique système Boirault.  
Annexe à la discussion. (1,400 mots & fig.)**1906**

Bulletin du Congrès des chemins de fer, n° 7, juillet, p. 810.

**Pont à bascule servant à déterminer les pressions des  
différentes roues des locomotives et véhicules de chemins  
de fer, avec appareil de levage commun, système Zeidler.**  
(750 mots & fig.)



**1906** **62.** (01 & **625** .1 (01  
Bulletin du Congrès des chemins de fer, n° 7, juillet, p. 814.

Voie expérimentale pour essais de matériaux de super-structure et de ballastage. (250 mots & fig.)

**1906** **625** .216 (.42)  
Bulletin du Congrès des chemins de fer, n° 7, juillet, p. 815.

Les accouplements automatiques en Angleterre. (450 mots.)

**1906** **385** .517.1  
Bulletin du Congrès des chemins de fer, n° 7, juillet, p. 815.

Réorganisation de la caisse de retraite des agents du « Lancashire & Yorkshire Railway ». (400 mots.)

**1906** **016** .385. (02  
Bulletin du Congrès des chemins de fer, n° 7, juillet, p. 65.

Bibliographie mensuelle des chemins de fer. — Livres. (26 fiches.)

**1906** **016** .385. (05  
Bulletin du Congrès des chemins de fer, n° 7, juillet, p. 68.

Bibliographie mensuelle des chemins de fer. — Périodiques. (173 fiches.)

**Bulletin de la Société d'encouragement  
pour l'industrie nationale. (Paris.)**

**1906** **625** .216  
Bull. de la Soc. d'encourag. pour l'ind. nat., n° 6, juin, p. 621.

ROZÉ (C.). — Rapport présenté au nom du comité des arts mécaniques sur un appareil d'attelage automatique des wagons de M. Boirault. (3,600 mots & fig.)

**1906** **621** .132.3  
Bull. de la Soc. d'encourag. pour l'ind. nat. n° 6, juin, p. 688.

Locomotives avec distribution à soupapes. (500 mots & fig.)

**1906** **669**  
Bull. de la Soc. d'encourag. pour l'ind. nat. n° 2, juillet, p. 87.

GUILLET (L.). — Recherches récentes faites sur les alliages industriels. Leur importance. (6,500 mots, 2 tableaux & fig.)

**1906** **669**  
Bull. de la Soc. d'encourag. pour l'ind. nat., n° 2, juillet, p. 159.

GUILLET (L.). — Étude générale des laitons spéciaux. (7,500 mots, tableaux & fig.)

**1906** **62.** (01  
Bull. de la Soc. d'encourag. pour l'ind. nat., n° 2, juillet, p. 205.

FRÉMONT (Ch.). — Résistance au cisaillement des aciers de construction. (2,500 mots & fig.)

**1906** **669**  
Bull. de la Soc. d'encourag. pour l'ind. nat., n° 2, juillet, p. 213.

DESLANDES. — Action chimique du four Martin acide. (1,800 mots & fig.)

**1906** **62.** (01  
Bull. de la Soc. d'encourag. pour l'ind. nat., n° 2, juillet, p. 223.

GUILLERY. — Mesure de la limite élastique des métaux. (1,300 mots & fig.)

**Bulletin de la Société des Ingénieurs civils  
de France. (Paris.)**

**1906** **625** .3  
Bulletin de la Soc. des ing. civ. de France, n° 3, mars, p. 507.

LÉVY-LAMBERT (A.). — Les chemins de fer à crémaillère. (14,000 mots, 2 tableaux & fig.)

**Bulletin des transports internationaux  
par chemins de fer. (Bern.)**

**1906** **625** .1 (.436)  
Bulletin des transports intern. par ch. de fer, n° 6, juillet, p. 234.

DRAGONI (L.). — Les nouveaux chemins de fer des Alpes autrichiennes et leur rôle dans le trafic international. (3,000 mots.)

**Génie civil. (Paris.)**

**1906** **625** .241  
Génie civil, n° 1252, 9 juin, p. 87.

Wagons plates-formes américains pour le transport des lourdes charges. (1,200 mots & fig.)

**1906** **656** .222.5  
Génie civil, n° 1253, 16 juin, p. 106.

Moyens de réduire les intervalles entre les trains sur les lignes à circulation intense. (1,700 mots et fig.)

**1906** **625** .13  
Génie civil, n° 1254, 23 juin, p. 113.  
— n° 1255, 30 — p. 135.

LEMAIRE (E.). — Le tunnel du Simplon. (9,500 mots, 3 tableaux & fig.)

**1906** **621** .116 & **621** .133.3  
Génie civil, n° 1257, 14 juillet, p. 164.

DANTIN (Ch.). — Chaudière industrielle à éléments amovibles, système Ch. Bourdon. (2,600 mots & fig.)



1906

Génie civil, n° 1257, 14 juillet, p. 167.

HERZOG (S.). — Automotrice à essence de pétrole pour voie ferrée normale. (1,000 mots & fig.)

1906

Génie civil, n° 1257, 14 juillet, p. 168.

TABARIÈS DE GRANDSAIGNES. — Le transport des matières dangereuses au congrès de chimie de Rome. (4,000 mots.)

**Journal des transports. (Paris.)**

1906

Journal des transports, n° 26, 30 juin, p. 301.

Les résultats de 1905. — Le Métropolitain de Paris. (2,000 mots & 3 tableaux.)

1906

Journal des transports, n° 28, 14 juillet, p. 325.

Les résultats de 1905. — Réseau de l'Est. (1,500 mots & 1 tableau.)

**Revue économique internationale. (Bruxelles.)**

1906

Revue économique internationale, n° 3, juin, p. 447.

HERSENT (G.). — Les grandes routes mondiales. (8,000 mots.)

1906

Revue économique internationale, n° 1, juillet, p. 218.

BELLET (D.). — Chronique des transports. (5,000 mots.)

**Revue générale des chemins de fer et des tramways. (Paris.)**

1906

Revue générale des chemins de fer, n° 6, juin, p. 489.

ASSELIN & COLLIN (G.). — Notes de voyage en Amérique. — Matériel roulant. (10,000 mots, 3 tableaux & fig.)

1906

Revue générale des chemins de fer, n° 6, juin, p. 529.

BEYNET. — Note sur les injections de ciment pratiquées dans le souterrain de Limonest (Rhône), sur la ligne de Lozanne à Givors. (1,700 mots, 2 tableaux & fig.)

1906

Revue générale des chemins de fer, n° 6, juin, p. 540.

Statistique des chemins de fer suisses pour l'année 1903. (1,100 mots & 9 tableaux.)

621 .132.8

656 .227

385 .113 (.44)

385 .113 (.44)

385 .22

385 .1

625 .2

625 .12

313 .385 (.494)

1906

Revue générale des chemins de fer, n° 6, juin, p. 548.

Matériel de voies, et signaux pour chemins de fer et tramways exposés à Liège en 1905. Tableau répéteur d'aiguilles, système Dumont et Baignères. (1,200 mots & fig.)

1906

Revue générale des chemins de fer, n° 6, juin, p. 553.

Appareil Kaptein pour l'étude des freins continus. (2,500 mots & fig.)

1906

Revue générale des chemins de fer, n° 6, juin, p. 560.

Appareil à descendre les roues. (700 mots & fig.)

1906

Revue générale des chemins de fer, n° 6, juin, p. 562.

Disposition auxiliaire pour actionner, au moyen de la vapeur, le frein des roues motrices des locomotives. (200 mots & fig.)

1906

Revue générale des chemins de fer, n° 6, juin, p. 562.

Chargeur mécanique américain. (800 mots & fig.)

1906

Revue générale des chemins de fer, n° 1, juillet, p. 3.

ASSELIN & COLLIN (Georges). — Notes de voyage en Amérique. — Ateliers. (10,700 mots, 3 tableaux & fig.)

1906

Revue générale des chemins de fer, n° 1, juillet, p. 35.

LEMERCIER (Ch.). — Voiture de l'assistance publique pour le transport d'enfants aux sanatoria de Berck et d'Hendaye. (2,600 mots & fig.)

1906

Revue générale des chemins de fer, n° 1, juillet, p. 45.

Résumé du rapport général du « Board of Trade » sur les accidents survenus en 1904 sur les chemins de fer du Royaume-Uni. (1,800 mots & tableaux.)

1906

Revue générale des chemins de fer, n° 1, juillet, p. 55.

Nécrologie. — M. Blagé. (850 mots.)

1906

Revue générale des chemins de fer, n° 1, juillet, p. 57.

Revue des questions de transports. — Les résultats de l'exploitation en 1904 : France, Angleterre et Allemagne. (5,200 mots & 2 tableaux.)

656 .257

625 .251

621 .138.5

621 .135.5

621 .133.1

621 .7 (.73)

625 .232

313 : 656 .28 (.42)

385 . (09.2)

385 .113 (.44 + .42 + .43)



**1906** **621 .33**  
 Revue générale des chemins de fer, n° 1, juillet, p. 66.  
 Système Farnham de traction électrique par troisième  
 rail renversé. (400 mots & fig.)

**1906** **621 .133.3**  
 Revue générale des chemins de fer, n° 1, juillet, p. 68.  
 Tôles en acier au nickel pour chaudières. (850 mots  
 & 2 tableaux.)

**1906** **621 .133.2**  
 Revue générale des chemins de fer, n° 1, juillet, p. 70.  
 Plaques de foyer en cuivre arsenical. (500 mots.)

**Revue de mécanique. (Paris.)**

**1906** **51. (08)**  
 Revue de mécanique, n° 6, juin, p. 568.  
 Les machines à calculer. (8,000 mots & fig.)

**Revue politique et parlementaire. (Paris.)**

**1906** **625 .13**  
 Revue politique et parlementaire, n° 145, juillet, p. 5.  
 SARTIAUX (A.). — Le tunnel sous la Manche.  
 (18,000 mots.)

**In German.**

**Annalen für Gewerbe und Bauwesen. (Berlin.)**

**1906** **656 .221**  
 Annalen für Gewerbe und Bauw., N° 696, 15. Juni, p. 223.  
 DENNINGHOFF. — Ueber die Zugwiderstände der  
 Eisenbahnfahrzeuge. (6,400 Wörter & Fig.)

**1906** **656 .259**  
 Annalen für Gewerbe und Bauw., N° 697, 1. Juli, p. 1.  
 LUX (F.). — Der Frahmische Frequenz- und Ge-  
 schwindigkeitsmesser. (4,800 Wörter & Fig.)

**1906** **625 .143.4**  
 Annalen für Gewerbe und Bauw., N° 697, 1. Juli, p. 17.  
 Schienenstuhl Patent Urbanitzky. (200 Wörter & Fig.)

**1906** **625 .4**  
 Annalen für Gewerbe und Bauw., N° 698, 15. Juli, p. 21.  
 MÜLLER (W.-A.). — Die Loschwitz Berg-Schwebe-  
 bahn. (3,200 Wörter, Tabellen & Fig.)

**Archiv für Eisenbahnwesen. (Berlin.)**

**1906** **385 .1 (.47)**  
 Archiv für Eisenbahnwesen, Heft 4, Juli-August, p. 705.  
 MATTHESIIUS (O.). — Russische Eisenbahnpolitik  
 (1881 bis 1903). (12,000 Wörter & 1 Tabelle.)

**1906** **385 .1 (.431)**  
 Archiv für Eisenbahnwesen, Heft 4, Juli-August, p. 740.  
 SCHREMMER. — Der Etat der preussisch-hessischen  
 Eisenbahnverwaltung für das Etatsjahr 1906. (1,000  
 Wörter & Tabellen.)

**1906** **385 .517**  
 Archiv für Eisenbahnwesen, Heft 4, Juli-August, p. 754.  
 Wohlfahrtseinrichtungen der königlich württember-  
 gischen Verkehrsanstalten. (2,200 Wörter & 1 Ta-  
 belle.)

**1906** **385 .113 (.489)**  
 Archiv für Eisenbahnwesen, Heft 4, Juli-August, p. 762.  
 Die Eisenbahnen in Dänemark im Betriebsjahre  
 1904-1905. (600 Wörter & Tabellen.)

**1906** **313 .385 (.460)**  
 Archiv für Eisenbahnwesen, Heft 4, Juli-August, p. 778.  
 Die Eisenbahnen in Spanien. (Tabellen.)

**1906** **313 .385 (.497.2)**  
 Archiv für Eisenbahnwesen, Heft 4, Juli-August, p. 797.  
 Die bulgarischen Staatsbahnen im Jahre 1904.  
 (700 Wörter & 1 Tabelle.)

**1906** **313 .385 .71)**  
 Archiv für Eisenbahnwesen, Heft 4, Juli-August, p. 803.  
 Die Eisenbahnen Canadas in den Jahren 1902-1903  
 und 1903-1904. (Tabellen.)

**Beton und Eisen. (Berlin.)**

**1906** **625 .142.4**  
 Beton und Eisen, Heft VII, p. 172.  
 Die Betoneisen-Schwellen. (400 Wörter & Fig.)

**1906** **624 .2 (01 & 721 .9 (01**  
 Beton und Eisen, Heft VII, p. 175.

KAUFMANN (G.). — Kontinuierliche Balken und sta-  
 tisch unbestimmte Systeme im Eisenbetonbau (1,200 Wör-  
 ter, 1 Tabelle & Fig.)



**Elektrische Bahnen und Betriebe.**  
**Zeitschrift für Verkehrs- und Transportwesen.**  
(München.)

**1906** **621 .336**  
Elektrische Bahnen und Betriebe, Heft 19, 4. Juli, p. 356.  
Wechselstrombahn der Mailänder Ausstellung. (1,800 Wörter & Fig.)

**1906** **621 .33**  
Elektrische Bahnen und Betriebe, Heft 21, 24. Juli, p. 389.  
HERZOG (S.). — Der elektrische Betrieb im Simplontunnel. (2,000 Wörter & Fig.)

**OÖsterreichische Eisenbahn-Zeitung.** (Wien.)  
**1906** **656 .235**  
Österreichische Eisenbahn-Zeitung, Nr 19, 15. Juni, p. 169.

Die Fortentwicklung des vereinfachten Abfertigungsvorgangs. (1,400 Wörter.)

**Organ für die Fortschritte des Eisenbahnwesens in technischer Beziehung.** (Wiesbaden.)

**1906** **625 .143.3**  
Organ für die Fortschritte des Eisenbahnw., Heft 6, p. 109.  
LUBIMOFF (L. von). — Zur Frage der Abnutzung der Eisenbahnschienen. (2,300 Wörter, 5 Tabellen & Fig.)

**1906** **624 .8**  
Organ für die Fortschritte des Eisenbahnw., Heft 6, p. 117.  
JOOSTING (P.). — Eine neue Einrichtung für ungleicharmige Drehbrücken. (900 Wörter & Fig.)

**1906** **625 .216**  
Organ für die Fortschritte des Eisenbahnw., Heft 6, p. 118.  
HAHNE. — Neue Zug- und Stoss-Vorrichtung für Lokomotiven mit einstellbarer hinterer Laufachse. (350 Wörter & Fig.)

**1906** **656 .212.8**  
Organ für die Fortschritte des Eisenbahnw., Heft 6, p. 119.  
ZIMMERMANN (F.). — Ladelehre für nach Italien übergehende Eisenbahnwagen. (700 Wörter & Fig.)

**1906** **625 .233**  
Organ für die Fortschritte des Eisenbahnw., Heft 6, p. 124.  
Elektrische Zugbeleuchtung, Bauart Leitner-Lucas. (1,100 Wörter & Fig.)

**1906** **621 .33**  
Organ für die Fortschritte des Eisenbahnw., Heft 6, p. 125.  
Die Chamonixbahn. (3,000 Wörter & Fig.)

**Schweizerische Bauzeitung.** (Zürich.)

**1906** **621 .132.8**  
Schweizerische Bauzeitung, Nr 24, 16. Juni, p. 285.

Neue Lokomotiven der Brunigbahn für gemischten Betrieb. (1,000 Wörter & Fig.)

**1906** **625 .13**  
Schweizerische Bauzeitung, Nr 24, 16. Juni, p. 290.  
Einspurige und zweispurige Alpentunnel. (900 Wörter, 1 Tabelle & Fig.)

**1906** **625 .13**  
Schweizerische Bauzeitung, Nr 26, 30. Juni, p. 309.

PRESSEL (K.). — Die Bauarbeiten am Simplontunnel. (1,200 Wörter & Fig.)

**1906** **656 .221**  
Schweizerische Bauzeitung, Nr 4, 28. Juli, p. 39.

STIX (O.). — Studie über den Luftwiderstand von Eisenbahnzügen in Tunnelröhren. (1,500 Wörter & Fig.)

**1906** **656 .257**  
Schweizerische Bauzeitung, Nr 4, 28. Juli, p. 41.

KOHLFÜRST (L.). — Elektromotorisches Handstellwerk für Weichen und Signale. (1,600 Wörter & Fig.)

**Zeitschrift für Architektur und Ingenieurwesen.** (Wiesbaden.)

**1906** **624 .2 (01**  
Zeitschrift für Architektur und Ingenieurw., Heft 4, p. 294.

FRANCKE (A.). — Der Parabelträger mit elastisch eingespannten Kämpfern. (1,200 Wörter & Fig.)

**1906** **721 .9 (01**  
Zeitschrift für Architektur und Ingenieurw., Heft 4, p. 301.

PILGRIM (H.). — Berechnung der Betoneisen-Konstruktionen. (5,500 Wörter & Fig.)

**Zeitschrift für Kleinbahnen.** (Berlin.)

**1906** **313 : 625 .61**  
Zeitschrift für Kleinbahnen, Heft 7, Juli, p. 407.

ZEZULA (F.). — Statistik der schmalspurigen Eisenbahnen für das Betriebsjahr 1903-1904. (2,500 Wörter & Tabellen.)



**Zeitschrift des österreichischen Ingenieur- und Architekten-Vereines. (Wien.)**

**1906** **625 .13**  
Zeit. des öst. Ingen.- und Arch.-Ver., N° 25, 22. Juni, p. 369.

BLODNIG (M. J.). — Die Bauschwierigkeiten beim Bosrucktunnel. (2,700 Wörter & Fig.)

**1906** **656 .257**  
Zeit. des öst. Ingen.- und Arch.-Ver., N° 30, 27. Juli, p. 431.

HROMATKA (F.). — Selbsttätiges Universal-Stellwerk, System Alfred Monard. (2,000 Wörter & Fig.)

**Zeitschrift des Vereines deutscher Ingenieure. (Berlin.)**

**1906** **624 .8**  
Zeit. des Vereines deutscher Ingen., N° 26, 30. Juni, p. 1009.

VAN LOENEN-MARTINET (J. J. W.) & DUFOUR F. C.). — Die Bewegungseinrichtungen der neuen Eisenbahnbrücke über den Nordsee-Kanal bei Velsen. 2,500 Wörter, 1 Tabelle & Fig.)

**1906** **656 .212.6**  
Zeit. des Vereines deutscher Ingen., N° 27, 7. Juli, p. 1057.

KAMMERER. — Versuche an der Kohlenumladeanlage in Breslau. (2,800 Wörter & Fig.)

**1906** **624 .8**  
Zeit. des Vereines deutscher Ingen., N° 28, 14. Juli, p. 1089.

BUZEMAN (C.). — Die Herrenbrücke bei Lübeck. 5,500 Wörter & Fig.)

**Zeitung des Vereines deutscher Eisenbahnverwaltungen. (Berlin.)**

**1906** **625 .143.4**  
Zeitung des Vereines, N° 46, 20. Juni, p. 737.

Eiserne Doppelstossschwellen als tadellose Stossanordnung und beste Verhütung des Wanderns der Schienen. 2,300 Wörter, 1 Tabelle & Fig.)

**1906** **385 .13**  
Zeitung des Vereines, N° 47, 23. Juni, p. 753.

SCHULZE (W. A.). — Finanzielle Wirkung der Eisenbahnfahrkartensteuer im Deutschen Reiche (2,400 Wörter.)

**1906** **625 .13**  
Zeitung des Vereines, N° 48, 27. Juni, p. 769.  
— N° 49, 30. — p. 785.

VON MÜHLENFELS. — Die Simplonfeier. (6,500 Wörter.)

**1906** **656 .231 (.434)**  
Zeitung des Vereines, N° 50, 4. Juli, p. 801.

Personentarifreform in Württemberg. (1,700 Wörter.)

**1906** **385 .13**  
Zeitung des Vereines, N° 51, 7. Juli, p. 818.

Fahrkartensteuer. (3,600 Wörter.)

**1906** **656 .222.6**  
Zeitung des Vereines, N° 52, 11. Juli, p. 833.  
— N° 53, 14. — p. 849.

CAUER (W.). — Zur Beschleunigung des Güterverkehrs und des Wagenumschlags. (7,300 Wörter.)

**1906** **385 .(07.4)**  
Zeitung des Vereines, N° 53, 14. Juli, p. 853.

Das österreichische Eisenbahnmuseum. (2,700 Wörter.)

**1906** **385 .517.2**  
Zeitung des Vereines, N° 54, 18. Juli, p. 865.  
— N° 55, 21. — p. 877.

WEBER. — Die Einheit der Arbeiterversicherung für die Staatseisenbahnverwaltung. (2,800 Wörter & Tabellen.)

**Zentralblatt der Bauverwaltung. (Berlin.)**

**1906** **721 .9**  
Zentralblatt der Bauverwaltung, N° 52, 27. Juni, p. 327.

LABES (J.). — Wie kann die Anwendung des Eisenbetons in der Eisenbahnverwaltung wesentlich gefördert werden? (4,500 Wörter & Fig.)

**1906** **721 .9**  
Zentralblatt der Bauverwaltung, N° 52, 27. Juni, p. 331.

LABES (J.). — Vorläufige Bestimmungen für das Entwerfen und die Ausführung von Ingenieurbauten in Eisenbeton im Bezirke der Eisenbahndirektion Berlin. (1,400 Wörter & Fig.)

**In English.**

**American Engineer and Railroad Journal. (New York.)**

**1906** **621 .132.5**  
American Engineer & R. Journal, No. 7, July, p. 262.

Simple consolidation locomotive with Walschaert valve gear. (700 words & fig.)



**Bulletin of the American Railway Engineering and Maintenance of Way Association. (Chicago.)**

**1906** **624.** (01  
Bull. Americ. Ry. Eng. & Maint. of Way Ass. No. 71, Jan., p. 4.  
Report of Committee No. XV. — On iron and steel structures. (14,000 words, tables & fig.)

**1906** **656.** 212  
Bull. Americ. Ry. Eng. & Maint. of Way Ass. No. 71, Jan., p. 59.  
Report of Committee No. XIV. — On yards and terminals. (12,000 words, tables & fig.)

**1906** **624.** (01  
Bull. Amer. Ry. Eng. & Maint. of Way Ass., No. 71, Jan., p. 103.  
Report of Committee No. VII. — On wooden bridges and trestles (4,700 words, tables & fig.)

**1906** **625.** 142.2  
Bull. Amer. Ry. Eng. & Maint. of Way Ass., No. 72, Feb., p. 4.  
Report of Committee No. III. — On ties. (7,200 words, 1 table & fig.)

**1906** **625.** 142.2  
Bull. Amer. Ry. Eng. & Maint. of Way Ass., No. 72, Feb., p. 39.  
Discussion of proposed standard method for analysis of coal-tar creosote and zinc-chloride. (12,000 words & 1 table.)

**1906** **656.** 25 (01  
Bull. Amer. Ry. Eng. & Maint. of Way Ass., No. 73, March, p. 4.  
Report of Committee No. X. — On signaling and interlocking. (7,500 words, 1 table & fig.)

**1906** **625.** 1 (01  
Bull. Amer. Ry. Eng. & Maint. of Way Ass., No. 73, March, p. 56.  
Report of Committee No. V. — On track. (3,500 words, 4 tables & fig.)

**1906** **625.** 11  
Bull. Amer. Ry. Eng. & Maint. of Way Ass., No. 73, March, p. 72.  
Report of Committee No. I. — On roadway. (32,000 words, tables & fig.)

**1906** **625.** 142.4  
Bull. Amer. Ry. Eng. & Maint. of Way Ass., No. 75, May, p. 4.  
CUSHING (W. C.). — Comparative value of cross-ties of different materials. (1,000 words & 3 tables.)

**1906** **625.** 123  
Bull. Amer. Ry. Eng. & Maint. of Way Ass., No. 75, May, p. 10.  
PARKHURST (H. W.). — The requisite waterway for railroad culverts. (1,300 words, tables & fig.)

**1906** **625.** 144.4  
Bull. Amer. Ry. Eng. & Maint. of Way Ass., No. 76, June, p. 4.  
CUSHING (W. C.). — Discussion of Committee report on ballasting in Bulletin No. 70. (4,800 words & fig.)

**Bulletin of the International Railway Congress. (Brussels.)**

**1906** **656.** 257  
Bulletin of the Railway Congress, No. 7, July, p. 1041.

GADOW. — Wire ropes used in transmissions for operating switches and signals : trials made in order to determine the best specification for such ropes. (5,300 words, tables & fig.)

**1906** **625.** 253  
Bulletin of the Railway Congress, No. 7, July, p. 1035.

Tests of Westinghouse brakes for fast trains, made on the Bavarian State Railway. (Note communicated by the administration of that railway.) (1,650 words, 1 table & fig.)

**1906** **625.** 253  
Bulletin of the Railway Congress, No. 7, July, p. 1062.

DOYEN (J.). — Some remarks on the subject of the Munich trials of fast train brakes. (1,900 words.)

**1906** **625.** 143.5  
Bulletin of the Railway Congress, No. 7, July, p. 1066.

X. — New armoured pickled wood bedplate. (1,400 words & fig.)

**1906** **624.** 63 & 721 .9  
Bulletin of the Railway Congress, No. 7, July, p. 1071.

Concrete and imbedded metal (question IV, 7<sup>th</sup> session). Discussion. (10,500 words.)

**1906** **621.** 134  
Bulletin of the Railway Congress, No. 7, July, p. 1097.

Locomotives of great power (question V, 7<sup>th</sup> session). Discussion. (40,700 words.)

**1906** **621.** 132.8  
Bulletin of the Railway Congress, No. 7, July, p. 1174.

COLEMAN (F. C.). — Steam motor vehicle for the Indian State Railway. (450 words & fig.)

**1906** **621.** 132.8  
Bulletin of the Railway Congress, No. 7, July, p. 1177.

Petrol motor for hauling railway carriages. (1,400 words & fig.)



**1906** **62. (01 06)**  
Bulletin of the Railway Congress, No. 7, July, p. 1183.  
International Association for testing materials.  
Congress at Brussels in 1906.) (550 words.)

**1906** **016.385. (02)**  
Bulletin of the Railway Congress, No. 7, July, p. 65.  
Monthly bibliography of railways. — Books. (26 labels.)

**1906** **016.385. (05)**  
Bulletin of the Railway Congress, No. 7, July, p. 68.  
Monthly bibliography of railways. — Periodicals.  
(173 labels.)

**Engineer. (London.)**

**1906** **621.131.3**  
Engineer, No. 2638, July 20, p. 53.  
American experience with compound locomotives.  
(1,600 words.)

**1906** **656.283**  
Engineer, No. 2638, July 20, p. 67.  
The Salisbury Railway accident. (950 words.)

**1906** **621.132.3**  
Engineer, No. 2638, July 20, p. 74.  
Four-cylinder compound locomotive, North-Eastern  
railway. (100 words & fig.)

**Engineering. (London.)**

**1906** **621.132.3**  
Engineering, No. 2112, June 22, p. 833.  
Six-coupled passenger express locomotive; Caledonian  
Railway. (600 words & fig.)

**1906** **621.133.3**  
Engineering, No. 2112, June 22, p. 835.  
The economy of locomotive boiler-coverings. (1,400  
words, 1 table & fig.)

**1906** **624.8**  
Engineering, No. 2113, June 29, p. 841.  
Viaduct over the river Barrow near Waterford. (2,200  
words & fig.)

**1906** **656.283**  
Engineering, No. 2114, July 6, p. 19.  
The Salisbury railway accident. (1,900 words & fig.)

**Engineering Magazine. (London.)**

**1906** **621.33**  
Engineering Magazine, July, p. 551.

KNOWLTON (H. S.). — A study of electric-railway  
operating cost and revenue. (1,400 words & tables.)

**Engineering News. (New York.)**

**1906** **625.4 & 625.13**  
Engineering News, No. 23, June 7, p. 619.

An official report on heat conditions in the New York  
subway by chief engineer Geo. S. Rice. (7,000 words  
& fig.)

**1906** **621.332**  
Engineering News, No. 24, June 14, p. 643.

Transmission and distribution system, Long Island  
R. R. (3,800 words & fig.)

**1906** **656.256.2**  
Engineering News, No. 24, June 14, p. 648.

Block and interlocking signals in the electrical zone of  
the New York Central & Hudson River R. R. (3,300 words  
& fig.)

**1906** **625.252**  
Engineering News, No. 24, June 14, p. 653.

Brake beams for 60,000, 80,000 and 100,000 lb. freight  
cars. (3,500 words & fig.)

**1906** **621.335**  
Engineering News, No. 25, June 21, p. 688.

HILD (F. W.). — The gasoline car for interurban  
service. (6,300 words & fig.)

**1906** **625.143.5**  
Engineering News, No. 25, June 21, p. 694.

Screw spikes and wooden tie-plates for railway track.  
(1,500 words & fig.)

**1906** **624. (01)**  
Engineering News, No. 25, June 21, p. 695.

A new method of calculating bridge stresses under  
wheel loads. (2,500 words & fig.)

**1906** **621.131.3**  
Engineering News, No. 25, June 21, p. 701.

Recent experience with compound locomotives.  
(2,500 words & 1 table.)



**1906** **624 .63 (01)**  
Engineering News, No. 26, June 28, p. 718.  
LUTEN (D. B.). — Empirical formulas for reinforced arches. (2,800 words & fig.)

**1906** **725 .32**  
Engineering News, No. 3, July 19, p. 58.  
A large railway freight house and warehouse at Pittsburg, Pa. (2,500 words & fig.)

**1906** **656 .256**  
Engineering News, No. 3, July 19, p. 70.  
Some recent block signal systems for electric railways. (2,500 words & fig.)

**1906** **621 .133.2 & 621 .133.3**  
Engineering News, No. 3, July 19, p. 76.  
WICKHORST (M. H.). — Fire-box steel-failures and specifications. (4,000 words & fig.)

**Great Western Railway Magazine. (London.)**

**1906** **621 .33 (.42)**  
Great Western Railway Magazine, July, p. 130.  
SMITH (R. T.). — Electric supply for traction, power, and lighting in the G. W. R. London district. (2,800 words & fig.)

**Indian Engineering. (Calcutta.)**

**1906** **621 .135.2**  
Indian Engineering, No. 23, June 9, p. 367.  
DOD (F. W.). — Wear of flanges and speed over facing points. (1,000 words & fig.)

**Institution of Mechanical Engineers. (London.)**

**1906** **62. (01)**  
Institut. of Mechanic. Engin., No. 1, January-February, p. 5.  
IZOD (E. G.). — Behaviour of materials of construction under pure shear. (14,000 words, tables & fig.)

**Locomotive Magazine. (London.)**

**1906** **621 .133.7**  
Locomotive Magazine, No. 166, June 15, p. 96.  
Tender water scoop, G. E. R. (450 words & fig.)

**Page's Weekly. (London.)**

**1906** **621 .132.1**  
Page's Weekly, No. 96, July 13, p. 74.  
Locomotives for colonial service. (1,700 words & fig.)

**Railroad Gazette. (New York.)**

**1906** **621 .132.5**  
Railroad Gazette, No. 24, June 15, p. 613.  
Consolidation locomotive for the New York Central lines. (1,000 words & fig.)

**1906** **725 .33**  
Railroad Gazette, No. 24, June 15, p. 619.  
STUART (J. C.). — Improved round house facilities. (1,200 words & fig.)

**1906** **621 .132.1 (.73)**  
Railroad Gazette, No. 24, June 15, p. 641.  
FOWLER (G. L.). — Recent development of American passenger locomotives. (2,200 words & fig.)

**1906** **621 .134.4**  
Railroad Gazette, No. 24, June 15, p. 644.  
WILLE (H. V.). — Balanced compound locomotives. (1,300 words & fig.)

**1906** **621 .335**  
Railroad Gazette, No. 24, June 15, p. 648.  
GORDON (R.). — New York Central electric locomotives. (1,400 words & fig.)

**1906** **625 .232**  
Railroad Gazette, No. 25, June 22, p. 687.  
Standard all-steel 60-ft. postal car for the Harriman lines. (500 words & fig.)

**Railway Age. (Chicago.)**

**1906** **621 .332**  
Railway Age, No. 1566, June 15, p. 1010.  
Power transmission line and third rail system of the Long Island Railroad. (6,500 words & fig.)

**1906** **621 .331**  
Railway Age, No. 1567, June 22, p. 1218.  
Pennsylvania railroad's extension to New York and Long Island. Rotary converter substations of the Long Island Railroad. (8,500 words & fig.)



**Railway Engineer. (London.)**

- 1906** **656 .251**  
 Railway Engineer, No. 318, July, p. 214.  
 The signalling of the Victoria (New) station; L., Brighton and S. C. Railway. (3,000 words & fig.)

**Railway and Engineering Review. (Chicago.)**

- 1906** **621 .131.3**  
 Railway and Engineering Review, No. 23, June 9, p. 408.  
 Some speculation on the P. R. R. tests. (2,000 words, tables & fig.)

- 1906** **656 .256.2**  
 Railway and Engineering Review, No. 23, June 9, p. 418.  
 — — — No. 25, — 23, p. 463.  
 Signaling in the electric zone, N. Y. C. & H. R. R. R. (2,300 words & fig.)

- 1906** **621 .332**  
 Railway and Engineering Review, No. 24, June 16, p. 454.  
 The electrical transmission system of the Long Island L. R. (2,000 words & fig.)

**Railway Gazette. (London.)**

- 1906** **621 .132.8, 621 .33 & 656 .27**  
 Railway Gazette, No. 22, June 15, p. 874.  
 Petrol-driven rail motor coaches for the Cape Government Railways. (300 words & fig.)
- 1906** **621 .33 & 656 .27**  
 Railway Gazette, No. 22, June 15, p. 894.  
 The gasoline car for interurban service. (4,800 words & fig.)

- 1906** **656 .237**  
 Railway Gazette, No. 23, June 22, p. 910.  
 Billing typewriters for railways. (1,300 words & fig.)

- 1906** **656 .211.7**  
 Railway Gazette, No. 23, June 22, p. 915.  
 DAVISON (R. C.) & BOARDMAN (B.). — Car ferry lines of American railroads. (2,200 words, 1 table & fig.)

- 1906** **621 .331**  
 Railway Gazette, No. 24, June 29, p. 940.  
 Great Western Railway's new London electric power station. (2,500 words & fig.)

- 1906** **621 .132.1 (.73)**  
 Railway Gazette, No. 24, June 29, p. 947.  
 FOWLER (G. L.). — Recent development of American passenger locomotives. (2,200 words & fig.)

- 1906** **621 .134.4**  
 Railway Gazette, No. 24, June 29, p. 950.  
 WILLE (H. V.). — Balanced compound locomotives. (1,300 words & fig.)

- 1906** **621 .335**  
 Railway Gazette, No. 24, June 29, p. 954.  
 GORDON (R.). — New York Central electric locomotives. (1,400 words & fig.)

- 1906** **625 .253**  
 Railway Gazette, No. 3, July 20, p. 66.  
 An advance in train braking. (800 words & fig.)

- 1906** **625 .13**  
 Railway Gazette, No. 3, July 20, p. 75.  
 The Pennsylvania tunnels under the East River. (5,400 words & fig.)

- 1906** **385 .4 (.73)**  
 Railway Gazette, No. 4, July 27, p. 109.  
 Organization of the Pennsylvania Railroad, 1906. (3,400 words & 1 table.)

- 1906** **388 (.73)**  
 Railway Gazette, No. 4, July 27, p. 116.  
 Rapid transit in Chicago. (2,400 words & fig.)

**Railway and Locomotive Engineering. (New York.)**

- 1906** **621 .133.4**  
 Railway and Locomotive Engineering, July, p. 330.  
 Locomotive front ends. (3,500 words & fig.)

**Railway Machinery. (New York.)**

- 1906** **621 .138.3**  
 Railway Machinery, June, p. 527.  
 Care and maintenance of freight and passenger engines at terminal to give maximum mileage and efficient service. (4,000 words.)



**Railway Magazine. (London.)**

**1906** **656 .222.1**  
 Railway Magazine, No. 109, July, p. 58.  
 ROUS-MARTEN (C.). — British locomotive practice  
 and performance. (3,600 words & fig.)

**Railway Maintenance and Structures. (New York.)**

**1906** **624 & 625 .123**  
 Railway Maintenance and Structures, No. 7, July, p. 162.  
 Areas of waterways for railroad culverts and bridges.  
 (8,500 words & fig.)

**Railway News. (London.)**

**1906** **385 .09.3 (.42)**  
 Railway News, No. 2219, July 14 (supplement).  
 The diamond jubilee of the London and North Western Railway Co. (12,000 words & fig.)

**Railway Times. (London.)**

**1906** **621 .33**  
 Railway Times, No. 26, June 30, p. 833.  
 Electric traction on the Lancashire and Yorkshire Railway. (3,000 words & fig.)

**Street Railway Journal. (New York.)**

**1906** **621 .331**  
 Street Railway Journal, No. 25, June 23, p. 968.  
 SMITH (W. N.). — The rotary-converter sub-stations  
 of the Long Island Railroad. (10,000 words & fig.)

**Tramway & Railway World. (London.)**

**1906** **621 .33**  
 Tramway & Railway World, July, p. 9.  
 New equipment and extensions of Liverpool and Southport electric line. Lancashire and Yorkshire Railway. (2,800 words & fig.)

**1906** **621 .33**

Tramway & Railway World, July, p. 21.  
 Hammersmith and City Railway electrification. (5,600 words & fig.)

**1906** **625 .143.3**

Tramway & Railway World, July, p. 44.  
 AMAN (F. T.). — Rail corrugation. (1,200 words & fig.)

**In Italian.**

**Bollettino della Società degli Ingegneri e degli architetti italiani. (Roma.)**

**1906** **625 .13**  
 Bollet. del. soc. degli ing. ed. arch. it., n° 24/25, 24 giugno, p. 315.  
 Il traforo del Sempione. (9,800 parole & 2 tavole.)

**Giornale del genio civile. (Roma.)**

**1906** **625 .1**  
 Giornale del genio civile, giugno, p. 327.  
 Il valico del Sempione. (3,600 parole, 9 tavole & fig.)

**Ingegneria ferroviaria. (Roma.)**

**1906** **621 .335**  
 Ingegneria ferroviaria, n° 13, 1° luglio, p. 199.  
 Le carrozze automotrici per la ferrovia elettrica monofase Blankenese-Amburgo-Ohlsdorf. (1,000 parole & fig.)

**1906** **621 .138.2 (.4 + .73)**  
 Ingegneria ferroviaria, n° 13, 1° luglio, p. 202.  
 LUZZATTO (V.). — Impianti di rifornimento di carbone per le locomotive in Europa e in America. (1,800 parole & fig.)

**1906** **625 .253**  
 Ingegneria ferroviaria, n° 14, 16 luglio, p. 214.  
 MELE (V.). — Sul freno Westinghouse ad azione rapida. (1,600 parole & fig.)



**Monitore delle strade ferrate e degli  
interessi materiali. (Torino.)**

**1906**

**385 .15 (.45)**

**Monitore delle strade ferrate, n° 16, 4 luglio, p. 243.**

**SAPORITO (V.). — Ancora sul riscatto delle Meridio-  
nali. (3,600 parole.)**

---

**In Dutch.**

---

**Ingenieur. ('s Gravenhage.)**

**1906**

**624 .2 (04)**

**Ingenieur, n° 25, 23 Juni, p. 454.**

**VAN SANDICK (R. A.). — Inleiding tot een bespre-  
king over Grey-balkliggers (B-profielen). (9,000 woorden,  
taferelen & fig.)**

---

---



# BIBLIOGRAPHIA UNIVERSALIS

COOPERATIVE PUBLICATION OF THE OFFICE BIBLIOGRAPHIQUE INTERNATIONAL, OF BRUSSELS

## MONTHLY BIBLIOGRAPHY OF RAILWAYS <sup>(1)</sup>

PUBLISHED UNDER THE SUPERVISION OF

L. WEISSENBRUCH,

Secretary General of the Permanent Commission of the International Railway Congress.

[016.383.(02)]

### I. — BIBLIOGRAPHY OF BOOKS

(September, 1906.)

#### In English.

1906 313 : 621 .33 (.7) & 313 : 625 .62 (.7)  
American street railway investments. The "red book"  
or 1906.

New York, McGraw Publishing Company. (13 × 9 1/2  
inches), cloth, 432 pages. (Price : \$5.)

1906 621 .14 (02)

BEAUMONT (W. Worby).

Motor vehicles and motors; their design, construction,  
and working by steam, oil, and electricity.

London, Archibald, Constable & Co. Volume II. (Price :  
2s.)

1906 669 .1

BLAIR (Andrew Alexander).

The chemical analysis of iron : a complete account of all  
the best known methods for the analysis of iron, steel, pig-  
iron, iron ore, etc.

Philadelphia, Lippincott. 6th ed., 8vo cl., 11-328 pages, il.  
Price : \$4.)

1906

HITT (Rodney).

Car builders' dictionary.

New York, Railroad Gazette. Edition for 1906, leather  
(12 × 9 inches), 738 pages and 6,344 illustrations. (Price :  
\$6.)

1906

656 .25 (06 (.73)

RAILWAY SIGNAL ASSOCIATION.

Digest of proceedings for eleven years, 1895-1905.

New York, H. S. Balliet, Secretary. Volume I, (9 × 6 inches),  
546 pages. (Price : \$4.)

1906

351 .812 (.42)

ROBERTSON (George Stuart).

The law of tramways and light railways in Great Britain.

London, Stevens & Son. (Price : 25s.)

1906

621 .133.7

WEHRENFENNIG (E. & F.).

The analysis and softening of boiler feed water. Translated  
by PATTERSON (D. W.).

New York, John Wiley & Sons. (9 × 6 inches), 200 pages,  
171 illustrations. (Price : \$4.)

(1) The numbers placed over the title of each book are those of the decimal classification proposed by the Railway Congress conjointly  
with the Office Bibliographique International, of Brussels. (See "Bibliographical Decimal Classification as applied to Railway Science," by  
L. WEISSENBRUCH, in the number for November, 1897, of the *Bulletin of the International Railway Congress*, p. 1500.)

N. B. — The Monthly Bibliography is printed on one side only so that it may be cut  
up into slips and pasted on labels for catalogues and indexes.



## II. — BIBLIOGRAPHY OF PERIODICALS

(August, 1906.)

### In French.

#### Bulletin du Congrès international des chemins de fer. (Bruxelles.)

**1906** **625 .251**  
Bulletin du Congrès des chemins de fer, n° 8, août, p. 817.  
FÜHR (A.). — Appareil de contrôle Kapteyn pour les  
essais de freins continus. (2,600 mots & fig.)

**1906** **621 .33 & 656 .222.1**  
Bulletin du Congrès des chemins de fer, n° 8, août, p. 827.  
Les essais de marche à grande vitesse faits en 1901  
sur la ligne de Berlin-Zossen. (7,500 mots, 3 tableaux  
& fig.)

**1906** **621 .33**  
Bulletin du Congrès des chemins de fer, n° 8, août, p. 853.  
Traction électrique (question VIII, 7<sup>e</sup> session). Discus-  
sion. (24,000 mots & fig.)

**1906** **621 .33**  
Bulletin du Congrès des chemins de fer, n° 8, août, p. 902.  
ROTA (C.) et GRISMAYER (E.). — Traction électrique  
(question VIII, 7<sup>e</sup> session). Lettre au sujet de l'exposé n° 4  
de M<sup>r</sup> Victor Tremontani. Annexe à la discussion.  
(300 mots.)

**1906** **621 .33**  
Bulletin du Congrès des chemins de fer, n° 8, août, p. 903.  
GULÁCSY (Coloman de). — Traction électrique  
(question VIII, 7<sup>e</sup> session). Remarques sur l'exposé n° 4  
de M<sup>r</sup> Victor Tremontani. Annexe à la discussion.  
(4,500 mots.)

**1906** **625 .233 & 625 .234**  
Bulletin du Congrès des chemins de fer, n° 8, août, p. 911.  
Éclairage, chauffage et ventilation des trains (ques-  
tion IX, 7<sup>e</sup> session). Discussion. (20,200 mots & 2 tableaux.)

**1906** **343 .385 (.3)**  
Bulletin du Congrès des chemins de fer, n° 8, août, p. 954.  
Les chemins de fer du monde. (2 tableaux.)

**1906** **621 .132.8**  
Bulletin du Congrès des chemins de fer, n° 8, août, p. 961.

COLEMAN (F. C.). — Voiture automotrice à vapeur  
pour les chemins de fer de l'État indien (Indian North  
Western). (500 mots & fig.)

**1906** **656 .256.3**  
Bulletin du Congrès des chemins de fer, n° 8, août, p. 962.

Signaux automatiques en Grande-Bretagne et sur le  
continent européen. (3,200 mots.)

**1906** **656 .281**  
Bulletin du Congrès des chemins de fer, n° 8, août, p. 967.  
L'accident de Salisbury. (1,200 mots.)

**1906** **385. (09.2)**  
Bulletin du Congrès des chemins de fer, n° 8, août, p. 971.  
Nécrologie : Ernest BLAGÉ. (900 mots & portrait.)

**1906** **625 .14 (01 & 385. (04)**  
Bulletin du Congrès des chemins de fer, n° 8, août, p. 973.

Compte rendu bibliographique : Étude sur les défor-  
mations des voies de chemins de fer et les moyens d'y  
remédier, par G. CUENOT. (250 mots.)

**1906** **621 .13 & 385. (04)**  
Bulletin du Congrès des chemins de fer, n° 8, août, p. 973.

Compte rendu bibliographique : La locomotive actuelle.  
Étude générale sur les types récents de locomotives  
à grande puissance, par Maurice DEMOULIN. (1,500  
mots.)

**1906** **016 .385. (02)**  
Bulletin du Congrès des chemins de fer, n° 8, août, p. 77.

Bibliographie mensuelle des chemins de fer. — Livres.  
(18 fiches.)

**1906** **016 .385. (05)**  
Bulletin du Congrès des chemins de fer, n° 8, août, p. 79.

Bibliographie mensuelle des chemins de fer. — Péri-  
odiques. (111 fiches.)



**Journal des transports. (Paris.)**

**1906** **385 .13 (.42)**  
Journal des transports, n° 29, 21 juillet, p. 337.  
Les trains ouvriers et l'impôt sur les voyageurs en Angleterre. (2,600 mots.)

**Revue générale des chemins de fer et des tramways. (Paris.)**

**1906** **625 .143.5**  
Revue générale des chemins de fer, n° 2, août, p. 75.  
PERROUD (E.). — Considérations générales sur la facilité de descente des tirefonds à leur mise en place. 3,800 mots & fig.)

**1906** **625 .23 (06.4)**  
Revue générale des chemins de fer, n° 2, août, p. 86.  
SCHUBERT (A.). — Le matériel roulant des chemins de fer à l'exposition universelle de Liège, 1905. 9,900 mots, 2 tableaux & fig.)

**1906** **385 .113 (.44)**  
Revue générale des chemins de fer, n° 2, août, p. 127.  
Résultats obtenus en 1905 sur les réseaux des six compagnies principales des chemins de fer français. 1,000 mots & 7 tableaux.)

**1906** **385 .14 (.73)**  
Revue générale des chemins de fer, n° 2, août, p. 140.  
La réglementation des tarifs de chemins de fer aux États-Unis. (1,800 mots.)

**1906** **625 .143.5**  
Revue générale des chemins de fer, n° 2, août, p. 143.  
Garnitures métalliques Thiollier pour la consolidation des attaches des rails. (350 mots & fig.) (V. *Bulletin du Congrès des chemins de fer*, n° 7, juillet 1906.)

**1906** **621 .131.3**  
Revue générale des chemins de fer, n° 2, août, p. 145.  
Résultats des essais effectués au laboratoire du Pennsylvania Railroad sur diverses locomotives pendant l'exposition de St. Louis. (1,000 mots.)

**In German.**

**Annalen für Gewerbe und Bauwesen. (Berlin.)**  
**1906** **385. (06.14)**  
Annalen für Gewerbe und Bauw., N° 699, 1. August, p. 42.  
SARRE. — Mitteilungen über die American Railway Association und ihr Wirken. (10,000 Wörter, 1 Tabelle & Fig.)

**1906** **625 .143.5**  
Annalen für Gewerbe und Bauw., N° 699, 1. August, p. 56.  
BIELSCHOWSKY (A.). — Schienenbefestigung ohne Kleineisenzeug auf eisernen Schwellen. (800 Wörter & Fig.)

**Organ für die Fortschritte des Eisenbahnwesens in technischer Beziehung. (Wiesbaden.)**

**1906** **621 .131.3**  
Organ für die Fortschritte des Eisenbahnw., 7/8. Heft, p. 131.  
LEITZMANN. — Ergebnisse der Versuchsfahrten mit einer  $\frac{2}{3}$  gekuppelten Vierzylinder-Lokomotive Grafenstadener Bauart. (4,200 Wörter, Tabellen & Fig.)

**1906** **725 .33**  
Organ für die Fortschritte des Eisenbahnw., 7/8. Heft, p. 143.  
KLOPSCH. — Heizung der Lokomotivschuppen. (350 Wörter & Fig.)

**1906** **625 .14 (01)**  
Organ für die Fortschritte des Eisenbahnw., 7/8. Heft, p. 143.  
FRANCKE (A.). — Der Balken mit elastisch gebundenen Auflagern bei Unsymmetrie mit Bezugnahme auf die Verhältnisse des Eisenbahnoberbaues. (2,000 Wörter & Fig.)

**1906** **621 .133.2**  
Organ für die Fortschritte des Eisenbahnw., 7/8. Heft, p. 147.  
BUSSE (O.). — Über das Dichthalten der Feuerbüchsen-Bodenringe. (500 Wörter.)

**1906** **621 .132.3**  
Organ für die Fortschritte des Eisenbahnw., 7/8. Heft, p. 148.  
MARESC (C.). — Heissdampf-Zwillings-Lokomotive für schwere Schnellzüge der Aussig-Teplitzer Eisenbahngesellschaft. (2,200 Wörter & Fig.)

**1906** **656 .259**  
Organ für die Fortschritte des Eisenbahnw., 7/8. Heft, p. 152.  
HEITZINGER (J.). — Das elektrische Verbindungssignal der Schnellzüge der deutschen und österreichischen Eisenbahnen. (3,500 Wörter & Fig.)

**1906** **656 .257**  
Organ für die Fortschritte des Eisenbahnw., 7/8. Heft, p. 160.  
Schaltungen elektrischer Stellwerke nach den Bauarten Siemens und Halske und Jüdel. (2,400 Wörter & Fig.)



**Österreichische Eisenbahn-Zeitung. (Wien.)**

**1906** **385 .517.6**  
 Österreichische Eisenbahn-Zeitung, Nr 22, 1. August, p. 201.  
 TERRA (O. DE). — Alkohol und Verkehrssicherheit.  
 (2,700 Wörter.)

**Elektrische Bahnen und Betriebe.  
 Zeitschrift für Verkehrs- und Transportwesen.  
 (München.)**

**1906** **625 .13**  
 Elektrische Bahnen und Betriebe, Heft 22, 4. August, p. 409.  
 HERZOG (S.). — Der elektrische Betrieb im Simplon-  
 tunnel. (3,600 Wörter & Fig.)

**Zeitschrift des österreichischen Ingenieur- und  
 Architekten-Vereines. (Wien.)**

**1906** **621 .131.1**  
 Zeit. des öst. Ingen.- und Archit.-Ver., Nr 31, 3. August, p. 441.  
 SANZIN (R.). — Das Leistungsgebiet der Dampfloko-  
 motive. (2,500 Wörter & Fig.)

**Zeitschrift für Kleinbahnen. (Berlin.)**

**1906** **313 : 625 .61**  
 Zeitschrift für Kleinbahnen, Heft 8, August, p. 510.  
 ŽEŽULA (F.). — Statistik der schmalspurigen Eisen-  
 bahnen für das Betriebsjahr 1903-1904. (Tabellen.)

**Zeitschrift des Vereines deutscher Ingenieure.  
 (Berlin.)**

**1906** **621 .132.5**  
 Zeit. des Vereines deutscher Ingen., Nr 31, 4. August, p. 1217.  
 METZELTIN. — Kurvenbewegliche Lokomotiven.  
 (800 Wörter, 1 Tabelle & Fig.)

**Zeitung des Vereines deutscher Eisenbahn-  
 verwaltungen. (Berlin.)**

**1906** **621 .14 (.43 + .44)**  
 Zeitung des Vereines, Nr 57, 28. Juli, p. 908.  
 PFLUG. — Die Prüfungsfahrten für Motorlastwagen  
 und Motoromnibusse in Frankreich und Deutschland  
 im Jahre 1905. (2,000 Wörter & Tabellen.)

**1906** **621 .33**  
 Zeitung des Vereines, Nr 58, 1. August, p. 917.  
 Der elektrische Betrieb der Wiesentalbahn. (1,500  
 Wörter & 1 Tabelle.)

**Zentralblatt der Bauverwaltung. (Berlin.)**

**1906** **656 .256**  
 Zentralblatt der Bauverwaltung, Nr 63, 4. August, p. 400.  
 Sperrvorrichtung unter den Erlaubnisfeldern für  
 Streckenblockung auf eingleisigen Bahnen. (1,900 Wör-  
 ter & Fig.)

**In English.**

**Bulletin of the International Railway Congress.  
 (Brussels.)**

**1906** **621 .133. (01**  
 Bulletin of the Railway Congress, No. 8, August, p. 1185.  
 BUSSE (O.). — Note on the steam production of  
 locomotive boilers. (700 words.)

**1906** **656 .222.1**  
 Bulletin of the Railway Congress, No. 8, August, p. 1188.  
 SARRAUTON (Henri de). — Table of speeds. (650  
 words, 1 table & fig.)

**1906** **625 .143.5**  
 Bulletin of the Railway Congress, No. 8, August, p. 1192.  
 X\*\*\* — Note on the metal screw bushes for streng-  
 thening rail fastenings, on the Thiollier system. (3,000  
 words, 6 tables & fig.)

**1906** **625 .255**  
 Bulletin of the Railway Congress, No. 8, August, p. 1203.  
 BRAUN (Rudolf). — The Westinghouse electro-  
 magnetic brake. (5,500 words & fig.)

**1906** **625 .13**  
 Bulletin of the Railway Congress, No. 8, August, p. 1220.  
 ROSENMUND (M.). — Final results of the Simplon  
 tunnel survey. (2,600 words, 1 table & fig.)

**1906** **621 .137.3**  
 Bulletin of the Railway Congress, No. 8, August, p. 1227.  
 Pooling locomotives (question VI, 7th session). Discus-  
 sion. (16,000 words.)

**1906** **625 .216**  
 Bulletin of the Railway Congress, No. 8, August, p. 1261.  
 Automatic couplers (question VII, 7th session). Discus-  
 sion. (23,500 words & fig.)



**1906** **625 .216**  
 Bulletin of the Railway Congress, No. 8, August, p. 1309.  
**PETTIGREW** (William F.). — Automatic couplers  
 (question VII, 7<sup>th</sup> session). Addenda to report No. 1  
 (England). Appendix to the discussion. (1,200 words  
 & fig.)

**1906** **625 .216**  
 Bulletin of the Railway Congress, No. 8, August, p. 1317.  
 Automatic couplers (question VII, 7<sup>th</sup> session). Note  
 on the Boirault automatic car coupler. Appendix to the  
 discussion. (1,200 words & fig.)

**1906** **656 .256.3**  
 Bulletin of the Railway Congress, No. 8, August, p. 1324.  
 Automatic signals in Great Britain and on the  
 Continent. (2,800 words.)

**1906** **621 .135.5 (01**  
 Bulletin of the Railway Congress, No. 8, August, p. 1328.  
 Comparative test of large locomotive air pumps.  
 (2,000 words, 3 tables & fig.)

**1906** **656 .212.8**  
 Bulletin of the Railway Congress, No. 8, August, p. 1335.  
 Weighbridge for determining the loads on the  
 different wheels of locomotives and other rolling stock,  
 with common raising mechanism, on the Zeidler system.  
 (700 words & fig.)

**1906** **625 .245**  
 Bulletin of the Railway Congress, No. 8, August, p. 1339.  
 Whitewashing car used on the Central London  
 Railway. (200 words & fig.)

**1906** **62. (01 & 625 .1 (01**  
 Bulletin of the Railway Congress, No. 8, August, p. 1340.  
 Experimental track for trials of superstructures and  
 ballast. (250 words & fig.)

**1906** **656 .281**  
 Bulletin of the Railway Congress, No. 8, August, p. 1341.  
 The accident at Salisbury. (1,450 words.)

**1906** **625 .14 (01 & 385. (04**  
 Bulletin of the Railway Congress, No. 8, August, p. 1344.  
 New books and publications : Étude sur les défor-  
 mations des voies de chemins de fer et les moyens d'y  
 remédier (Investigation concerning the deformations of  
 railway tracks and means of obviating them), by G. CUENOT.  
 (300 words.)

**1906** **016 .385. (02**  
 Bulletin of the Railway Congress, No. 8, August, p. 77.  
 Monthly bibliography of railways. — Books. (18 labels.)

**1906** **016 .385. (05**  
 Bulletin of the Railway Congress, No. 8, August, p. 79.  
 Monthly bibliography of railways. — Periodicals.  
 (111 labels.)

—————  
**Engineer. (London.)**

**1906** **656 .237.4**  
 Engineer, No. 2636, July 6, p. 1.  
 The Railway Clearing House. (3,500 words.)

**1906** **656 .259**  
 Engineer, No. 2637, July 13, p. 29.  
 Locomotive tachographs. (1,500 words & fig.)

**1906** **621 .132.3**  
 Engineer, No. 2639, July 27, p. 98.  
 High-speed Bavarian locomotive. (700 words & fig.)

—————  
**Engineering. (London.)**

**1906** **621 .132.3**  
 Engineering, No. 2116, July 20, p. 80.  
 Locomotive for the Hungarian State Railways. (1,000  
 words & fig.)

**1906** **656 .281**  
 Engineering, No. 2116, July 20, p. 87.  
 The Salisbury railway accident. (1,700 words.)

**1906** **621 .132.8**  
 Engineering, No. 2117, July 27, p. 107.  
 Steam coach for Central South African Railways.  
 (300 words & fig.)

**1906** **624 .63**  
 Engineering, No. 2117, July 27, p. 117.  
 Concrete bridge over Deep creek, Queensland Rail-  
 ways. (350 words & fig.)

**1906** **621 .14**  
 Engineering, No. 2118, August 3, p. 157.  
 The motor-bus and the motor-car. (3,200 words & fig.)



**190** **656 .212.6**  
**Engineering**, No. 2118, August 3, p. 165.  
 REE (H. S. C.). — Shipping coal at bute docks, Cardiff. (4,400 words, 1 table & fig.)

**1906** **625 .143.2**  
**Engineering**, No. 2118, August 3, p. 170.  
 COLBY (A. L.). — American and foreign rail specifications. (5,000 words & 3 tables.)

**1906** **621 .132.8**  
**Engineering**, No. 2119, August 10, p. 201.  
 Four-cylinder compound rack-adhesion locomotive; Benguella Railway, Portuguese West Africa. (650 words & fig.)

**1906** **621 .133.3**  
**Engineering**, No. 2121, August 24, p. 254.  
 The Robert water-tube locomotive boiler. (900 words & fig.)

**1906** **621 .132.8 & 656 .27**  
**Engineering**, No. 2121, August 24, p. 264.  
 RICHES (T. H.) & HASLAM (S. B.). — Railway motor-car traffic. (3,500 words, 3 tables & fig.)

**1906** **625 .232**  
**Engineering**, No. 2122, August 31, p. 287.  
 Bogie composite lavatory carriage for the South Eastern & Chatham Railway. (600 words & fig.)

**1906** **621 .132.4**  
**Engineering**, No. 2122, August 31, p. 299.  
 Goods locomotive for the Caledonian Railway. (500 words & fig.)

**Engineering News. (New York.)**

**1906** **385. (01) (.51)**  
**Engineering News**, No. 2, July 12, p. 25.  
 ASHMEAD (P. H.). — The Pekin-Hankow Railway in China. (2,300 words & fig.)

**Page's Weekly. (London.)**

**1906** **621 .132.8**  
**Page's Weekly**, No. 99, August 3, p. 239.  
 RICHES (T. H.) & HASLAM (S. B.). — Railway motor-car traffic. (1,200 words, 1 table & fig.)

**Railroad Gazette. (New York.)**

**1906** **625 .252. (01)**  
**Railroad Gazette**, No. 26, June 29, p. 691.  
 Tests of brake beams. (500 words, tables & fig.)

**1906** **656 .256.3**  
**Railroad Gazette**, No. 26, June 29, p. 705.  
 New York Central All-electric signaling at New York. (3,200 words & fig.)

**1906** **621 .132.3**  
**Railroad Gazette**, No. 26, June 29, p. 714.  
 Pacific locomotive for the Southern Railway. (500 words & fig.)

**1906** **625 .13**  
**Railroad Gazette**, No. 1, July 6, p. 11.  
 The Pennsylvania tunnels under the East River. (5,000 words & fig.)

**1906** **385 .4 (.73)**  
**Railroad Gazette**, No. 2, July 13, p. 37.  
 Organization of the Pennsylvania Railroad, 1906. (3,200 words & 1 table.)

**1906** **621 .132.8 & 625 .3**  
**Railroad Gazette**, No. 2, July 13, p. 40.  
 Rack locomotive for Manitou & Pike's Peak Railway. (800 words & fig.)

**1906** **621 .135.1**  
**Railroad Gazette**, No. 2, July 13, p. 42.  
 Welding locomotive frames. (1,900 words.)

**1906** **388 (.73)**  
**Railroad Gazette**, No. 2, July 13, p. 44.  
 Rapid transit in Chicago. (2,000 words & fig.)

**1906** **621 .135.5 (01)**  
**Railroad Gazette**, No. 2, July 13, p. 47.  
 Comparative test of large locomotive air pumps. (1,000 words & fig.)

**1906** **625 .172**  
**Railroad Gazette**, No. 3, July 20, p. 55.  
 The Lamb gasolene weed burner. (300 words & fig.)



**1906** **621 .132.8**  
*Railroad Gazette*, No. 3, July 20, p. 57.  
 Steam motor car for the Canadian Pacific. (450 words & fig.)

---

**1906** **621 .132.4**  
*Railroad Gazette*, No. 3, July 20, p. 58.  
 Mogul locomotives for the Panama excavation. (800 words & fig.)

---

**1906** **625 .142.3**  
*Railroad Gazette*, No. 3, July 20, p. 64.  
 The Carnegie steel tie. (800 words & fig.)

---

**1906** **621 .133.3**  
*Railroad Gazette*, No. 3, July 20, p. 66.  
 VAN ALSTYNE (D.). — Some essentials in locomotive boiler design. (2,500 words & fig.)

---

**1906** **656 .256.3**  
*Railroad Gazette*, No. 4, July 27, p. 86.  
 Combined manual and automatic block signaling on the C., N. O. & T. P. (600 words & fig.)

---

**1906** **621 .132.7**  
*Railroad Gazette*, No. 5, August 3, p. 98.  
 Heavy switching locomotive for the Pittsburg & Lake Erie. (500 words & fig.)

---

**1906** **621 .134.3**  
*Railroad Gazette*, No. 5, August 3, p. 102.  
 MELLIN (C. J.). — Special valve gears for locomotives. (3,600 words & fig.)

---

**1906** **624. (01**  
*Railroad Gazette*, No. 6, August 10, p. 123.  
 BUEL (A. W.). — Uniform live loads for railroad bridges, and shearing stress in webs of plate girders. (700 words, 1 table & fig.)

---

**1906** **625 .215**  
*Railroad Gazette*, No. 7, August 17, p. 138.  
 RAYMOND (W. G.). — Curve resistance. (2,000 words & fig.)

---

**1906** **621 .132.5**  
*Railroad Gazette*, No. 7, August 17, p. 148.  
 Mallet compound locomotive for the Great Northern. (600 words & fig.)

**1906** **621 .132.3**  
*Railroad Gazette*, No. 8, August 24, p. 160.  
 Four-cylinder compound express locomotive for the Prussian State Railways. (600 words & fig.)

---

**Railway Age. (Chicago.)**

**1906** **621 .135.1**  
*Railway Age*, No. 1570, July 13, p. 48.  
 Welding locomotive frames. (700 words & fig.)

---

**1906** **621 .132.7**  
*Railway Age*, No. 1572, July 27, p. 118.  
 Pittsburg & Lake Erie switching locomotive. (600 words & fig.)

---

**1906** **656 .254**  
*Railway Age*, No. 1571, July 20, p. 80.  
 BURDICK (H. L.) & SAUNDERS (W. T.). — The telephone in railroad service. (3,200 words & fig.)

---

**1906** **625 .143.2**  
*Railway Age*, No. 1575, August 17, p. 195.  
 Phosphorus in steel rails. (1,500 words.)

---

**1906** **625 .232**  
*Railway Age*, No. 1575, August 17, p. 198.  
 The new Pennsylvania steel coach. (400 words & fig.)

---

**1906** **621 .338**  
*Railway Age*, No. 1575, August 17, p. 200.  
 SMITH (W. N.). — Electric car equipment of the Long Island Railroad. (6,000 words & fig.)

---

**Railway and Engineering Review. (Chicago.)**

**1906** **62. (01**  
*Railway and Engineering Review*, No. 26, June 30, p. 486.  
 HATT (W. K.) & TURNER (W. P.). — Purdue university impact testing machine. (1,200 words, 3 tables & fig.)

---

**1906** **621 .335. (01**  
*Railway and Engineering Review*, No. 28, July 14, p. 525.  
 PERKINS (F. C.). — Electric locomotive tests on the Seebach-Wettingen Railway. (800 words & fig.)



**Railway Gazette. (London.)**

**1906**

**656.256.3**

**Railway Gazette, No. 2, July 13, p. 45.**

**New York Central All-electric signaling at New York.  
(3,000 words & fig.)**

---

**In Italian.**

---

**Ingegneria ferroviaria. (Roma.)**

**1906**

**385.15(.45)**

**Ingegneria ferroviaria, n° 15, 1° agosto, p. 237.**

**Il riscatto delle Meridionali. (1,900 parole.)**

---



MONTHLY BIBLIOGRAPHY OF RAILWAYS <sup>(1)</sup>

PUBLISHED UNDER THE SUPERVISION OF

L. WEISSENBRUCH,

Secretary General of the Permanent Commission of the International Railway Congress.

[ 016 .385. (02) ]

## I. — BIBLIOGRAPHY OF BOOKS

(October, 1906.)

## In French.

1905 385. (09.1 (.86)

BROCHET (M.).

Le réseau des chemins de fer colombiens de Bogota à l'Atlantique et le port de Bahia-Honda. Rapport général sur l'entreprise des voies ferrées colombiennes et du port de Bahia-Honda.

Angers-Paris, G. Lenormand. In-4° (325 × 245), 171 pages, 8 photographies et 1 carte.

1906 656 .23 (02)

COLSON (C.), ingénieur en chef des ponts et chaussées, conseiller d'État.

Transports et tarifs. Supplément annuel à la deuxième édition. Lois, règlements et actes administratifs postérieurs au 30 mars 1898. Statistiques mises à jour d'après les dernières publications françaises rapprochées des statistiques étrangères et des relevés historiques.

Poitiers, imprimerie Blais & Roy; Paris, librairie Laveur. In-8°, 46 pages.

1906 721 .9 (01)

FÉRET (R.), chef du laboratoire des ponts et chaussées, à Boulogne-s/Mer.

Étude expérimentale du ciment armé.

Paris, Gauthier-Villars. 1 volume in-8°, 778 pages, 197 figures. (Prix : 20 francs.)

1906 313 .385 (.44)

MINISTÈRE DES TRAVAUX PUBLICS.

Album de statistique graphique de 1900.

Paris, Imprimerie nationale. In-4° (335 × 260), 46 planches.

## In German.

1906 721 .9 (02)

Beton-Kalender 1907. Taschenbuch für den Beton- und Eisenbetonbau.

Berlin, Verlag von Wilhelm Ernst & Sohn. II. Jahrgang. Kl. in-8°, 2 teilen mit über 900 Textabbildungen und 1 Tafel. (Preis : 4 Mark.)

1906 721 .9 (01)

KOENEN (M.).

Grundzüge für die statische Berechnung der Beton- und Eisenbetonbauten.

Berlin, Ernst & Sohn. 3. Auflage. in-8°, 24 Seiten. (Preis : 1.50 Mark.)

1906 385. (09.1 (.43)

REICHSEISENBAHNAMT.

Übersichtskarte der Eisenbahnen Deutschlands nebst Verzeichnis der deutschen Eisenbahnstationen und ihrer Verwaltungen.

(Preis : 9 Mark.)

<sup>(1)</sup> The numbers placed over the title of each book are those of the decimal classification proposed by the Railway Congress conjointly with the Office Bibliographique International, of Brussels. (See "Bibliographical Decimal Classification as applied to Railway Science," by L. WEISSENBRUCH, in the number for November, 1897, of the *Bulletin of the International Railway Congress*, p. 1509.)

N. B. — The Monthly Bibliography is printed on one side only so that it may be cut up into slips and pasted on labels for catalogues and indexes.



**1906** **62.** (09.3)  
**Verein deutscher Ingenieure 1856-1906.** Zur Feier des  
50 jährigen Bestehens des Vereines.  
Berlin, Selbstverlag. In-8°, 22 Seiten mit Abbildungen.

**1906** **625 .12** (02)  
**WILLMANN (Prof. L. v.) & ZSCHOKKE (C.).**  
**Handbuch der Ingenieurwissenschaften.** 1. Tl. Vorar-  
beiten, Erd-, Grund-, Strassen- und Tunnelbau. 3. Bd.  
**Der Grundbau.**  
Leipzig, W. Engelmann. 4. Auflage, in-8°, xvi, 406 und  
vi Seiten, 304 Textabbildungen und 14 lithographierte  
Tafeln. (Preis : 12 Mark.)

**1906** **625 .13**  
**ZOLLINGER (A.),** Oberingenieur.  
**Berner Alpendurchstich.** Technischer Bericht mit Rent-  
abilitätsberechnung.  
Bern, Buchdruckerei Ott & Bolliger.

**In English.**

**1906** **385.** (09.3 (.73))  
**BAILEY (W. F.).**  
**The story of the first trans-continental railroad, its pro-  
jectors, construction and history.**  
Pittsburgh, Pa., Pittsburgh Printing Co. 16mo, 164 pages.  
(Price : \$2.)

**1906** **313 .385**  
**DIACOMIDIS (J. D.),** engineer, Egyptian State Railways.  
**Statistical tables of the working of railways in various  
countries up to the year 1904.**  
Cairo, Baader & Gross. Second edition. (Price : 16s.)

**1906** **385.** (09.3 (.54))  
**HUDDLESTON (Geo.),** C. I. E., chief superintendent  
E. I. Railway.  
**History of the East Indian Railway.**  
London, W. Thacker & Co.; Calcutta, Thacker Spink & Co.  
(Price : 7s. 6d.)

**1906** **621 .2** (01)  
**JUDE (Alexander).**  
**The theory of the steam turbine :** a treatise on the prin-  
ciples of construction of the steam turbine, with historical  
notes on its development.  
London, Charles Griffin & Co. (Price : 10s.)

**1906** **621 .116.** (02)  
**PICKWORTH (Charles N.).**  
**The indicator hand-book :** a practical manual for engi-  
neers. Part II. The indicator diagram : its analysis and  
calculation.  
Manchester and London, Emmott & Co.; New York, The  
D. Van Nostrand Company. Third edition. (Price : 3s.)

**1906** **385.** (02)  
**Universal directory of railway officials, 1906.**  
London, The Directory Publishing Company. 12th year,  
685 pages. (Price : 10s.)

**In Italian.**

**1906** **625 .62.** (08 (.45))  
**MINISTERO DEI LAVORI PUBBLICI** (Ufficio speciale  
delle ferrovie).  
**Relazione sull' esercizio delle tramvie italiane per l'anno  
1904.**  
Roma, tipografia dell' Unione cooperativa editrice. In-4°,  
279 pagine.



## II. — BIBLIOGRAPHY OF PERIODICALS

(September, 1906.)

### In French.

#### Bulletin du Congrès international des chemins de fer. (Bruxelles.)

**1906** 621.134.3  
Bulletin du Congrès des chemins de fer, n° 9, septemb., p. 977.  
VAUGHAN (H. H.). — L'emploi de la vapeur sur-  
chauffée sur les locomotives. (15,500 mots, tableaux & fig.)

**1906** 625.143.4 & 625.142.2  
Bulletin du Congrès des chemins de fer, n° 9, septemb., p. 1010.

BARSCHALL (Max). — Le joint à rail auxiliaire et  
l'usure des traverses. (1,800 mots & fig.)

**1906** 621.33 & 625.4  
Bulletin du Congrès des chemins de fer, n° 9, septemb., p. 1018.  
Électrification du terminus du « New York Central »  
à l'intérieur de New-York et aux abords de cette ville.  
(4,900 mots & fig.)

**1906** 621.131.3 & 656.222.1  
Bulletin du Congrès des chemins de fer, n° 9, septemb., p. 1033.  
Récents essais de marche à grande vitesse avec des  
locomotives à vapeur. (3,300 mots & 2 tableaux.)

**1906** 656.256.3  
Bulletin du Congrès des chemins de fer, n° 9, septemb., p. 1041.  
Block-system automatique (question X, 7<sup>e</sup> session).  
Discussion. (15,000 mots.)

**1906** 656.256.3  
Bulletin du Congrès des chemins de fer, n° 9, septemb., p. 1073.  
PLATT (C. H.). — Block-system automatique (ques-  
tion X, 7<sup>e</sup> session). Supplément à l'exposé n° 1. Annexe à  
la discussion. (3,000 mots, 8 tableaux & fig.)

**1906** 656.226  
Bulletin du Congrès des chemins de fer, n° 9, septemb., p. 1091.  
Bagages et colis de détail (question XI, 7<sup>e</sup> session).  
Discussion. (14,200 mots.)

**1906** 621.135.5 (01  
Bulletin du Congrès des chemins de fer, n° 9, septemb., p. 1121.  
Essais comparatifs de grandes pompes à air pour  
locomotives. (2,400 mots, 3 tableaux & fig.)

**1906** 621.132.8  
Bulletin du Congrès des chemins de fer, n° 9, septemb., p. 1130.  
Nouvelle voiture automotrice de l'« Union Pacific ».  
(550 mots & fig.)

**1906** 625.241  
Bulletin du Congrès des chemins de fer, n° 9, septemb., p. 1131.  
Wagon plat de 200,000 livres. (800 mots & fig.)

**1906** 625.245  
Bulletin du Congrès des chemins de fer, n° 9, septemb., p. 1132.  
Wagon à badigeonner en service sur le « Central  
London Railway ». (200 mots & fig.)

**1906** 656.28 (01  
Bulletin du Congrès des chemins de fer, n° 9, septemb., p. 1135.  
Rapport du colonel H. A. Yorke sur l'accident survenu  
le 2 janvier 1906 entre Strathaven et Stonehouse,  
Caledonian Railway. (1,800 mots & fig.)

**1906** 016.385.(02  
Bulletin du Congrès des chemins de fer, n° 9, septemb., p. 85.  
Bibliographie mensuelle des chemins de fer. — Livres.  
(20 fiches.)

**1906** 016.385.(05  
Bulletin du Congrès des chemins de fer, n° 9, septemb., p. 87.  
Bibliographie mensuelle des chemins de fer. — Péri-  
odiques. (191 fiches.)

#### Bulletin de la Société d'encouragement pour l'industrie nationale. (Paris.)

**1906** 385.(06.4 (.45)  
Bull. de la Soc. d'encourag. pour l'ind. nat., n° 7, juillet, p. 730.  
BERNHEIM (E.). — Le matériel des chemins de fer à  
l'exposition de Milan. (4,200 mots.)

#### Bulletin de la Société des ingénieurs civils de France. (Paris.)

**1906** 656.222.1 & 625.2 (01  
Bulletin de la Soc. des ing. civ. de France, n° 4, avril, p. 622.  
MARIÉ (G.). — Les grandes vitesses des chemins de  
fer. — Les oscillations du matériel et la voie. (18,000  
mots, 3 tableaux & fig.)



**1906** **625 .233 & 621 .32**  
Bulletin de la Soc. des ing. civ. de France, n° 4, avril, p. 685.

L'HOEST. — Éclairage électrique des trains de chemins de fer par le système L'Hoest-Pieper. (6,300 mots & fig.)

**1906** **624 .132.8**  
Bulletin de la Soc. des ing. civ. de France, n° 5, mai, p. 883.  
La locomotive Shay. (1,100 mots.)

**Bulletin des transports internationaux par chemins de fer. (Bern.)**

**1906** **656 .24**  
Bulletin des transports intern. par ch. de fer, n° 8, août, p. 275.  
De la responsabilité du chemin de fer et de ses agents pour les renseignements fournis par eux. (1,800 mots.)

**1906** **656 .235. (01**  
Bulletin des transports intern. par ch. de fer, n° 9, sept., p. 308.  
Du calcul du prix de transport basé sur le choix de la voie la plus avantageuse ou le tarif le plus économique. (2,000 mots.)

**Éclairage électrique. (Paris.)**

**1906** **621 .32 & 625 .233**  
Éclairage électrique, n° 34, 25 août, p. 293.

VALBREUZE (R. DE). — Nouveaux systèmes pour l'éclairage électrique des trains. (3,800 mots & fig.)

**1906** **621 .33**  
Éclairage électrique, n° 35, 1<sup>er</sup> septembre, p. 334.

SOLIER (A.). — Tramways électriques à récupération. (1,600 mots, 1 tableau & fig.)

**Génie civil. (Paris.)**

**1906** **621 .138.2**  
Génie civil, n° 1261, 11 août, p. 225.

Installations de chargement mécanique du charbon dans les dépôts de locomotives. (1,200 mots & fig.)

**1906** **621 .14**  
Génie civil, n° 1261, 11 août, p. 228.

ESPITALIER (G.). — Service régional d'omnibus automobiles sur la côte normande. (2,600 mots, 2 tableaux & fig.)

**1906** **621 .338**  
Génie civil, n° 1261, 11 août, p. 237.

Wagon spécial pour l'inspection du tunnel du Simplon. (450 mots & fig.)

**1906** **656 .237**  
Génie civil, n° 1262, 18 août, p. 243.

COUPAN (R.). — Préparateur d'itinéraires, système J. Forestier, avec commande à distance et enclenchement des appareils de voie et des signaux. (4,000 mots & fig.)

**1906** **624 .8**  
Génie civil, n° 1264, 1<sup>er</sup> septembre, p. 279.

Pont tournant sur le canal de la mer du Nord, à Velsen (Hollande). (2,400 mots & fig.)

**1906** **625 .233**  
Génie civil, n° 1265, 8 septembre, p. 300.

L'éclairage des wagons par becs à incandescence. (500 mots & fig.)

**1906** **621 .33 (.494)**  
Génie civil, n° 1266, 15 septembre, p. 305.

HERZOG (S.). — La traction électrique dans le tunnel du Simplon. (2,000 mots & fig.)

**1906** **656 .259**  
Génie civil, n° 1266, 15 septembre, p. 313.

Indicateur de vitesse et de fréquence, système Frahm. (1,200 mots & fig.)

**1906** **625 .242**  
Génie civil, n° 1266, 15 septembre, p. 314.

Wagons-trémies de 20 tonnes à déchargement automatique, système Malissard-Taza. (400 mots & fig.)

**1906** **656 .211.5**  
Génie civil, n° 1267, 22 septembre, p. 321.

DUMAS (A.). — La nouvelle gare maritime de la Compagnie générale transatlantique, au Havre. (3,200 mots, 1 tableau & fig.)

**1906** **625 .144.4**  
Génie civil, n° 1267, 22 septembre, p. 326.

SCHLÜSSEL (L.). — Le desserrage des vis dans les assemblages métalliques des voies de chemins de fer. (2,600 mots & fig.)

**Journal des transports. (Paris.)**

**1906** **656 .235.7**  
Journal des transports, n° 32, 11 août, p. 373.

— n° 33, 18 — p. 385.

HAGUET (H.). — Le projet Barthou sur le régime des colis postaux. (4,000 mots.)



**1906** **656 .235.5**  
Journal des transports, n° 35, 1<sup>er</sup> septembre, p. 409.  
Le transport des houilles. (2,500 mots & 3 tableaux.)

**Nouvelles annales de la construction. (Paris.)**

**1906** **624 .32**  
Nouvelles annales de la construction, n° 621, septembre, p. 129.  
COSYN (L.). — Pont-route au-dessus de la gare de Muysen (Belgique). (2,200 mots & fig.)

**Portefeuille économique des machines. (Paris.)**

**1906** **621 .132.5**  
Portefeuille économique des machines, n° 608, août, p. 113.  
MORIZOT (A.). — Les nouvelles locomotives compound à deux bogies moteurs de la Compagnie des chemins de fer du Nord. (3,000 mots & fig.)

**Revue générale des chemins de fer et des tramways. (Paris.)**

**1906** **625 .144 1**  
Revue générale des chemins de fer, n° 3, septembre, p. 151.  
Note sur la longueur maxima adoptée pour les rails de la voie courante. (1,700 mots.)

**1906** **625 .233**  
Revue générale des chemins de fer, n° 3, septembre, p. 154.  
SAILLOT (A.). — Note sur une machine à essayer les manchons des becs renversés des voitures de la Compagnie des chemins de fer de l'Ouest. (1,000 mots & fig.)

**1906** **625 .2 (06.4)**  
Revue générale des chemins de fer, n° 3, septembre, p. 157.  
SCHUBERT (A.). — Le matériel roulant des chemins de fer à l'exposition universelle de Liège, 1905. (5,000 mots & fig.)

**1906** **313 .385 (.44)**  
Revue générale des chemins de fer, n° 3, septembre, p. 181.  
Résultats obtenus en 1905 sur le réseau des chemins de fer de l'État français, d'après le compte d'administration publié de ladite année. (8 tableaux.)

**1906** **625 .1 (.494)**  
Revue générale des chemins de fer, n° 3, septembre, p. 187.  
Les voies d'accès au Simplon. (4,600 mots & fig.)

**1906** **625 .236**  
Revue générale des chemins de fer, n° 3, septembre, p. 200.  
Nettoyage des voitures par le vide ou l'air comprimé. (1,400 mots & fig.)

**1906** **621 .133.3**  
Revue générale des chemins de fer, n° 3, septembre, p. 202.  
Conférence de M. G. Jackson Churchward, sur les chaudières de très grande puissance. (2,100 mots & fig.)

**Revue de mécanique. (Paris.)**

**1906** **621 .1 (01)**  
Revue de mécanique, n° 1, juillet, p. 5.  
DUCHESNE (A.). — Les phénomènes thermiques dans les machines à vapeur. (11,500 mots, tableaux & fig.)

**Revue politique et parlementaire. (Paris.)**

**1906** **385 .113 (.65)**  
Revue politique et parlementaire, n° 146, août, p. 358.  
COLSON (C.). — Revue des questions de transports. — Les chemins de fer algériens en 1905. (2,400 mots.)

**1906** **625 .6 (.44)**  
Revue politique et parlementaire, n° 146, août, p. 364.  
COLSON (C.). — Revue des questions de transports. — Les chemins de fer d'intérêt local et les tramways ruraux en 1905. (1,100 mots.)

**1906** **385 .113 (.44) & 625 .62 (.44)**  
Revue politique et parlementaire, n° 146, août, p. 367.  
COLSON (C.). — Revue des questions de transports. — Les chemins de fer et les tramways urbains en 1905. (2,200 mots.)

**Revue universelle des mines, de la métallurgie, des travaux publics, des sciences et des arts appliqués à l'industrie. (Liège.)**

**1906** **624 .2**  
Revue universelle des mines, août, p. 133.  
GÉRARD (G. L.). — Calcul de la résistance au vent des colonnes supportant des fermes métalliques. (13,500 mots, tableaux & fig.)

**1906** **669 .1**  
Revue universelle des mines, août, p. 206.  
THIBEAU (J.). — L'électro-métallurgie de l'acier. (4,500 mots & fig.)

**Thomson-Houston. (Paris.)**

**1906** **621 .33. (09.1) (.45)**  
Thomson-Houston, n° 137, août, p. 855.  
Réseau des tramways des châteaux romains. (1,700 mots & fig.)



**In German.**

**Annalen für Gewerbe und Bauwesen. (Berlin.)**

**1906** **625 .13**  
Annalen für Gewerbe und Bauw., Nr 700, 15. August, p. 61.

**HAAS.** — Die Lüftungsanlage des Kaiser-Wilhelm-tunnels bei Cochem. (7,500 Wörter, 1 Tabelle & Fig.)

**1906** **621 .33. (09.1) (.43)**  
Annalen für Gewerbe und Bauw., Nr 701, 1. September, p. 81.  
— — — Nr 702, 15. — p. 101.

**SCHIMPF.** — Der elektrische Betrieb der Bahn ankenese-Ohlsdorf. (3,800 Wörter, 3 Tabellen & Fig.)

**Archiv für Eisenbahnwesen. (Berlin.)**

**1906** **621 .14**  
Archiv für Eisenbahnwesen, Heft 5, September-Oktober, p. 893.  
**VELLGUTH.** — Die heutigen Kosten des Automobil-mnibusbetriebes. (9,000 Wörter & Tabellen.)

**1906** **313 .385 (.47)**  
Archiv für Eisenbahnwesen, Heft 5, September-Oktober, p. 949.  
**MERTENS.** — Die russischen Eisenbahnen im Jahre 1903. (3,000 Wörter & Tabellen.)

**1906** **313 .385 (.43)**  
Archiv für Eisenbahnwesen, Heft 5, September-Oktober, p. 995.  
**THAMER (C.).** — Die Güterbewegung auf deutschen senbahnen im Jahre 1905 im Vergleich zu der in den Jahren 1902, 1903 und 1904. (400 Wörter & Tabellen.)

**1906** **313 .385 (.485)**  
Archiv für Eisenbahnwesen, Heft 5, September-Oktober, p. 1033.  
Die Eisenbahnen in Schweden im Jahre 1903-1904. 30 Wörter & Tabellen.)

**1906** **313 .385 (.45)**  
Archiv für Eisenbahnwesen, Heft 5, September-Oktober, p. 1043.  
Die Betriebsergebnisse der italienischen Eisenbahnen im Jahre 1903. (700 Wörter & Tabellen.)

**1906** **313 .385 (.439)**  
Archiv für Eisenbahnwesen, Heft 5, September-Oktober, p. 1059.  
**NAGEL (R.).** — Die Eisenbahnen Ungarns im Jahre 1904. (500 Wörter & Tabellen.)

**Beton und Eisen. (Berlin.)**

**1906** **624. (01)**  
Beton und Eisen, Heft VIII, August, p. 200.

**ANDERSEN (S. M.).** — Belastungsversuche mit Visintinisträgern für Gleisüberführung in Dänemark. (1,000 Wörter, 1 Tabelle & Fig.)

**1906** **624 .3**  
Beton und Eisen, Heft IX, September, p. 220.

**Gitterträgerbrücken, System Visintini.** (2,400 Wörter, 1 Tabelle & Fig.)

**Elektrische Bahnen und Betriebe. Zeitschrift für Verkehrs- und Transportwesen. (München.)**

**1906** **621 .33**  
Elektrische Bahnen und Betriebe, Nr 23, 14. August, p. 432.

**HERZOG (S.).** — Der elektrische Betrieb im Simplon-tunnel. (1,000 Wörter & Fig.)

**1906** **625 .143.5**  
Elektrische Bahnen und Betriebe, Nr 24, 24. August, p. 449.

**STEINER (F.).** — Der Scheinig und Hofmannsche Schienenschuh in seiner neuen Gestalt. (2,200 Wörter, 1 Tabelle & Fig.)

**1906** **621 .335**  
Elektrische Bahnen und Betriebe, Nr 24, 24. August, p. 459.  
**Benzin-elektrische Selbstfahrer im Bahnbetriebe.** (1,800 Wörter & Fig.)

**1906** **621 .336**  
Elektrische Bahnen und Betriebe, Nr 26, 14. September, p. 489.

**SCHEERER.** — Fahrdraht-Kraftanschlüsse bei elektrischen Strassenbahnen. (2,500 Wörter, 1 Tabelle & Fig.)

**Schweizerische Bauzeitung. (Zürich.)**

**1906** **621 .33 (.494)**  
Schweizerische Bauzeitung, Nr 9, 1. September, p. 101.

**KILCHMANN (C.).** — Elektrizitätswerk Luzern-Engelberg. (2,400 Wörter & Fig.)

**Zeitschrift des österreichischen Ingenieur- und Architekten-Vereines. (Wien.)**

**1906** **621 .131.1**  
Zeit. des öst. Ingen.- und Arch.-Ver., Nr 32, 10. August, p. 453.

**SANZIN (R.).** — Das Leistungsgebiet der Dampflok-motive. (1,800 Wörter, Tabellen & Fig.)



**Zeitung des Vereins deutscher Eisenbahnverwaltungen. (Berlin.)**

**1906** **656 .24**  
 Zeitung des Vereins, Nr 61, 11. August, p. 965.  
 COERMANN (W.). — Die Erstreckung der Eisenbahn-  
 nftpflcht auf Sachschaden. (1,800 Wörter.)

**1906** **656 .235.7**  
 Zeitung des Vereins, Nr 63, 18. August, p. 993.  
 GIESE (E.) & BLUM. — Beiträge zur Stückgutbeför-  
 derung auf amerikanischen Bahnen. (2,700 Wörter  
 & Fig.)

**1906** **656 .253**  
 Zeitung des Vereins, Nr 65, 25. August, p. 1025.  
 MARTENS (H. A.). — Das Ueberfahren der Halt-  
 signale durch Güterzüge. (3,200 Wörter & 2 Tabellen.)

**1906** **656 .222.1 (.73)**  
 Zeitung des Vereins, Nr 66, 29. August, p. 1037.  
 KUNTZEMÜLLER (A.). — Der Empire State Express-  
 zug. (2,500 Wörter, 1 Tabelle & Fig.)

**1906** **656 .253**  
 Zeitung des Vereins, Nr 70, 12. September, p. 1089.  
 WÜRTZLER (W.). — Elektrisch betriebene Vor-  
 signale. (1,700 Wörter & Fig.)

**In English**

**American Engineer  
 and Railroad Journal. (New York.)**

**1906** **621 .132.8**  
 American Engineer & R. Journal, No. 8, August, p. 291.  
 Four cylinder balance simple locomotive. (1,000  
 words & fig.)

**1906** **385 .523 & 621 .7**  
 American Engineer & R. Journal, No. 8, August, p. 304.  
 COZAD (W. S.). — A rational method for the intro-  
 duction and management of piece-work in a railroad  
 shops. (2,600 words & fig.)

**1906** **621 .132.8**  
 American Engineer & R. Journal, No. 9, September, p. 332.  
 Steam motor car. (600 words & fig.)

**1906** **621 .132.5**  
 American Engineer & R. Journal, No. 9, September, p. 334.  
 Consolidation locomotive with Allfree Hubbell cylin-  
 ders and valves. (1,200 words & fig.)

**Bulletin of the American Railway Engineering  
 and Maintenance of Way Association. (Chicago.)**

**1906** **624 .01**  
 Bull. Amer. Ry. Eng. & Maint. of Way Ass., No. 77, July, p. 3.  
 Recommended practice in contracting for steel railroad  
 bridges. (4,000 words, 3 tables & fig.)

**Bulletin of the International Railway Congress.  
 (Brussels.)**

**1906** **621 .133.2**  
 Bulletin of the Railway Congress, No. 9, September, p. 1345.  
 BUSSE (O.). — Note on the tightness of foundation  
 rings. (900 words.)

**1906** **625 .143.4 & 625 .142.2**  
 Bulletin of the Railway Congress, No. 9, September, p. 1348.  
 BARSCHALL (Max). — Wheel carrying rail joints  
 and tie preservation. (1,500 words & fig.)

**1906** **621 .131.1**  
 Bulletin of the Railway Congress, No. 9, September, p. 1355.  
 SCHLOSS (Dr. Karl). — Note on determining the  
 power of locomotives by means of the speed curves.  
 (2,800 words, 1 table & fig.)

**1906** **621 .134.3**  
 Bulletin of the Railway Congress, No. 9, September, p. 1365.  
 Superheated steam on the Canadian Pacific Railway.  
 (4,000 words & 3 tables.)

**1906** **621 .33**  
 Bulletin of the Railway Congress, No. 9, September, p. 1373.  
 Electric traction (question VIII, 7<sup>th</sup> session). Discussion.  
 (22,500 words & fig.)

**1906** **621 .33**  
 Bulletin of the Railway Congress, No. 9, September, p. 1421.  
 ROTA (C.) & GRISMAYER (E.). — Electric traction  
 (question VIII, 7<sup>th</sup> session). Letter on Mr. Victor Tremon-  
 tani's report No. 4. Appendix to the discussion. (300 words.)

**1906** **621 .33**  
 Bulletin of the Railway Congress, No. 9, September, p. 1422.  
 GULÁCSY (Coloman DE). — Electric traction (ques-  
 tion VIII, 7<sup>th</sup> session). Remarks on Mr. Victor Tremontani's  
 report No. 4. Appendix to the discussion. (4,300 words.)

**1906** **625 .233 & 625 .234**  
 Bulletin of the Railway Congress, No. 9, September, p. 1429.  
 Lighting, heating and ventilation of trains (ques-  
 tion IX, 7<sup>th</sup> session). Discussion. (18,200 words & 2 tables.)



**1906** **313 .385 (.3)**  
Bulletin of the Railway Congress, No. 9, September, p. 1468.  
The world's railways. (2 tables.)

**1906** **621 .132.8**  
Bulletin of the Railway Congress, No. 9, September, p. 1473.  
Union Pacific motor car No. 7. (650 words & fig.)

**1906** **625 .241**  
Bulletin of the Railway Congress, No. 9, September, p. 1474.  
200,000 lb. capacity flat car. (950 words & fig.)

**1906** **625 .242**  
Bulletin of the Railway Congress, No. 9, September, p. 1476.  
30-ton ironstone wagon; North Eastern Railway.  
1,600 words & fig.)

**1906** **656 .211.5**  
Bulletin of the Railway Congress, No. 9, September, p. 1483.  
Butterfly station platform canopies on the New York Central (450 words & fig.)

**1906** **656 .28 (01**  
Bulletin of the Railway Congress, No. 9, September, p. 1485.  
Colonel H. A. Yorke's report on the accident of January 2, 1906, between Strathaven and Stonehouse on the Caledonian Railway. (4,300 words & fig.)

**1906** **385. (09.2**  
Bulletin of the Railway Congress, No. 9, September, p. 1491.  
Obituary: Ernest BLAŽEK. (850 words & portrait.)

**1906** **016 .385. (02**  
Bulletin of the Railway Congress, No. 9, September, p. 85.  
Monthly bibliography of railways. — Books. (20 labels.)

**1906** **016 .385. (05**  
Bulletin of the Railway Congress, No. 9, September, p. 87.  
Monthly bibliography of railways. — Periodicals.  
191 labels.)

**Engineer. (London.)**

**1906** **656 .211.7**  
Engineer, No. 2646, September 14, p. 263.  
The transporter bridge at Newport. (2,800 words & fig.)

**1906** **621 .134.4**  
Engineer, No. 2646, September 14, p. 271.  
Compound locomotives. (1,300 words.)

**1906** **385 .1 (.42)**  
Engineer, No. 2647, September 21, p. 297.  
The railways of the United Kingdom. (1,500 words.)

**Engineering. (London.)**

**1906** **656 .211.5**  
Engineering, No. 2125, September 21, p. 380.  
Electric passenger-lifts for the Baker-Street and Waterloo Railway. (4,500 words & fig.)

**1906** **621 .132.4**  
Engineering, No. 2125, September 21, p. 385.  
Vauclain balanced compound locomotive for the Chicago and Eastern Illinois Railroad. (1,600 words & fig.)

**1906** **385 .1 (.42)**  
Engineering, No. 2125, September 21, p. 391.  
British railway economics. (2,600 words.)

**1906** **669 .1**  
Engineering, No. 2125, September 21, p. 401.  
YORK (J. E.). — Improvements in rolling iron and steel. (3,500 words & fig.)

**1906** **669 .1**  
Engineering, No. 2125, September 21, p. 405.  
STEAD (J. E.). — Segregation in steel ingots. (3,000 words.)

**Engineering Magazine. (London.)**

**1906** **621 .7**  
Engineering Magazine, September, p. 897.  
JACOBS (H. W.). — Organization and economy in the railway machine shop. (2,900 words & fig.)

**Engineering News. (New York.)**

**1906** **625 .14 & 625 .4**  
Engineering News, No. 5, August 2, p. 113.  
The track construction of underground railways. (4,500 words & fig.)

**1906** **625 .12**  
Engineering News, No. 6, August 9, p. 142.  
NEELY (S. T.). — The cost of steam shovel work in railway betterment. (2,000 words & fig.)



**Journal of the Western Society of Engineers.**  
(Chicago.)

**1906** **624 .338**  
Journal of the Western Society of Engineers, No. 3, June, p. 269.  
STARRING (M. B.) & FLEMING (H. B.). — Electric street cars for city service. (7,500 words, 1 table & fig.)

**1906** **62. (01**  
Journal of the Western Society of Engineers, No. 3, June, p. 297.  
SMITH (E. G.). — Urban tendencies of population as affecting the problems of engineer. (10,000 words & 2 tables.)

**1906** **624. (01**  
Journal of the Western Society of Engineers, No. 3, June, p. 321.  
CURTIS (W. T.). — A new method of calculating bridge stresses by means of end shears. (4,500 words & fig.)

**1906** **625 .13**  
Journal of the Western Society of Engineers, No. 3, June, p. 332.  
MERRICK (A. W.). — The Clay slide at the Boone viaduct, Boone, Iowa. (7,500 words & fig.)

**Proceedings of the American Society of Civil Engineers.** (New York.)

**1906** **625 .13**  
Proceed. of the Amer. Soc. of Civil Eng., No. 6, August, p. 440.  
CHURCHILL (C. S.). — The ventilation of tunnels 5,000 words & fig.)

**Proceedings of the Institution of Civil Engineers.** (London.)

**1905-1906** **625 .112**  
Proceedings of the Inst. of Civil Eng., vol. CLXIV, p<sup>t</sup> II, p. 196.  
UPCOTT (F. R.). — The railway-gauges of India. (45,000 words, tables & fig.)

**1905-1906** **621 .131**  
Proceedings of the Inst. of Civil Eng., vol. CLXIV, p<sup>t</sup> II, p. 329.  
DALBY (W. E.). — The economical working of locomotives. (4,000 words, 5 tables & fig.)

**Railroad Gazette.** (New York.)

**1906** **385 .112**  
Railroad Gazette, No. 10, September 7, p. 203.  
Unit costs of railroad building. (450 words & fig.)

**Railway Engineer.** (London.)

**1906** **625 .13 & 625 .14**  
Railway Engineer, No. 319, August, p. 244.  
The New York subway. (3,600 words & fig.)

**1906** **621 .132.3**  
Railway Engineer, No. 320, September, p. 289.  
"Atlantic" engines; North British Railway. (350 words & fig.)

**Railway and Engineering Review.** (Chicago.)

**1906** **621 .134.2**  
Railway and Engineering Review, No. 30, July 28, p. 570.  
Haberkorn crankless valve gear for locomotives. (1,100 words & fig.)

**1906** **621 .134.3**  
Railway and Engineering Review, No. 31, August 4, p. 587.  
Poppet valves on locomotives. (2,400 words & fig.)

**1906** **621 .338**  
Railway and Engineering Review, No. 32, August 11, p. 606.  
SMITH (W. N.). — The electric car equipment of the Long Island Railroad. (4,200 words & fig.)

**1906** **625 .232**  
Railway and Engineering Review, No. 32, August 11, p. 612.  
Interurban test car of the university of Illinois. (1,600 words & fig.)

**1906** **621 .33**  
Railway and Engineering Review, No. 32, August 11, p. 617.  
Problems of heavy electric traction. (3,200 words & fig.)

**1906** **625 .142.3 & 625 .142.4**  
Railway and Engineering Review, No. 33, August 18, p. 627.  
Steel and concrete-steel ties on the L. S. & M. S. Ry. (1,600 words & fig.)

**1906** **621 .13 & 621 .33**  
Railway and Engineering Review, No. 36, September 8, p. 688.  
Parallel mileage of electric and steam railroads. (3,200 words & fig.)

**Railway Gazette.** (London.)

**1906** **625 .142.3**  
Railway Gazette, No. 5, August 3, p. 144.  
The Carnegie steel tie. (900 words & fig.)



<b>1906</b>	<b>621 .133.3</b>
Railway Gazette, No. 5, August 3, p. 146.	
VAN ALSTYNE (D.). — Some essentials in locomotive boiler design. (2,800 words & fig.)	
<b>1906</b>	<b>656 .256.3</b>
Railway Gazette, No. 6, August 10, p. 174.	
Combined manual and automatic block signaling on the C., N. O. & T. P. (600 words & fig.)	
<b>1906</b>	<b>621 .132.7</b>
Railway Gazette, No. 7, August 17, p. 194.	
Heavy switching locomotive for the Pittsburg & Lake Erie. (400 words & fig.)	
<b>1906</b>	<b>621 .134.3</b>
Railway Gazette, No. 7, August 17, p. 198.	
MELLIN (C. J.). — Special valve gears for locomotives. (4,200 words & fig.)	
<b>1906</b>	<b>656 .222.6</b>
Railway Gazette, No. 8, August 24, p. 214.	
— No. 9, — 31, p. 247.	
STEPHENSON (W. T.). — Some principles of freight traffic working. (3,200 words, 2 tables & fig.)	
<b>1906</b>	<b>625 .215</b>
Railway Gazette, No. 9, August 31, p. 250.	
RAYMOND (W. G.). — Curve resistance. (2,200 words & fig.)	
<b>1906</b>	<b>621 .132.3</b>
Railway Gazette, No. 10, September 7, p. 276.	
Four cylinder compound express locomotive for the Prussian State Railways. (700 words & fig.)	
<b>1906</b>	<b>624 .1</b>
Railway Gazette, No. 11, September 14, p. 300.	
A novel method of cylinder pier reinforcement. (5,200 words & fig.)	
<b>1906</b>	<b>621 .136.3</b>
Railway Gazette, No. 11, September 14, p. 309.	
Water pick-up apparatus, Great Eastern Railway. (400 words & fig.)	
<b>1906</b>	<b>385 .112</b>
Railway Gazette, No. 12, September 21, p. 327.	
Unit costs of railroad building. (450 words & fig.)	

**Railway Machinery. (New York.)**

<b>1906</b>	<b>621 .135.3</b>
Railway Machinery, August, p. 617.	
FOWLER (G. L.) & MELLIN (C. J.). — The designing of a locomotive. — Spring rigging and equalizers. (2,000 words & fig.)	

**Railway Magazine. (London.)**

<b>1906</b>	<b>656 .222.1 (09.3 (.42)</b>
Railway Magazine, No. 110, August, p. 108.	
Speed of trains and development of services. (3,500 words & fig.)	
<b>1906</b>	<b>621 .13 (09.3 (.42)</b>
Railway Magazine, No. 110, August, p. 118.	
The locomotives. (1,800 words & fig.)	
<b>1906</b>	<b>625 .232. (09.3 (.42)</b>
Railway Magazine, No. 110, August, p. 127.	
Royal travellers. (1,400 words & fig.)	
<b>1906</b>	<b>625 .231. (09.3 (.42)</b>
Railway Magazine, No. 110, August, p. 133.	
Progress in railway carriage building. (2,200 words & fig.)	
<b>1906</b>	<b>625 .232. (09.3 (.42)</b>
Railway Magazine, No. 110, August, p. 139.	
Growth of third-class travel. (2,100 words & fig.)	
<b>1906</b>	<b>656 .222.1 (09.3 (.42)</b>
Railway Magazine, No. 110, August, p. 145.	
ROUS-MARTEN (C.). — Some "diamond jubilee" runs. (2,000 words & fig.)	
<b>1906</b>	<b>656 .222.6 (09.3 (.42)</b>
Railway Magazine, No. 110, August, p. 163.	
The goods department. (2,800 words & fig.)	
<b>1906</b>	<b>659. (09.3 (.42)</b>
Railway Magazine, No. 110, August, p. 172.	
Railway advertising. (2,200 words & fig.)	
<b>1906</b>	<b>625 .1 (09.3 (.42)</b>
Railway Magazine, No. 110, August, p. 180.	
Permanent way and works. (1,400 words & fig.)	
<b>1906</b>	<b>656 .25 (09.3 (.42)</b>
Railway Magazine, No. 110, August, p. 186.	
The growth of signalling during sixty years. (1,000 words & fig.)	
<b>1906</b>	<b>656 .262. (09.3 (.42)</b>
Railway Magazine, No. 110, August, p. 191.	
Railway hotels on wheels- and otherwise. (2,800 words & fig.)	



**1906** **621 .14** (09.3 (.42) & **621 .132.8** (09.3 (.42)  
Railway Magazine, No. 110, August, p. 201.

Motor car services. (1,800 words & fig.)

**1906** **621 .132.1** (.42)  
Railway Magazine, No. 111, September, p. 238.

ROUS-MARTEN (C.). — British locomotive practice and performance. (3,000 words & fig.)

**1906** **656 .25** (01 (.73)  
Railway Magazine, No. 111, September, p. 249.

Railway signalling in America. (2,200 words & fig.)

**1906** **656 .257**  
Railway Magazine, No. 111, September, p. 267.

How trains are controlled. (1,800 words & fig.)

**Railway and Locomotive Engineering.** (New York.)

**1906** **624 .8**  
Railway and Locomotive Engineering, No. 9, September, p. 399.

Bascule bridges. (2,400 words & fig.)

**Railway Times.** (London.)

**1906** **621 .132.4**  
Railway Times, No. 8, August 25, p. 209.

New bogie goods engines for the Caledonian Railway. (400 words & fig.)

**1906** **621 .132.8**  
Railway Times, No. 9, September 1, p. 237.

RICHES (T. H.) & HASLAM (S. B.). — Railway motor car traffic. (2,500 words, 1 table & fig.)

**Street Railway Journal.** (New York.)

**1906** **621 .33**  
Street Railway Journal, No. 5, August 4, p. 184.

Operating results on the Lancashire & Yorkshire electric division. (1,800 words & fig.)

**1906** **621 .338**  
Street Railway Journal, No. 6, August 11, p. 216.

— No. 7, — 18, p. 250.

SMITH (W. N.). — The electric car equipment of the Long Island Railroad. (11,500 words & fig.)

**1906** **624 .63**  
Street Railway Journal, No. 9, September 1, p. 343.

A single track, reinforced-concrete electric railway bridge near Belvidere, Ill. (2,500 words, 1 table & fig.)

**1906** **621 .33** (01  
Street Railway Journal, No. 10, September 8, p. 378.

ASHE (S. W.). — Interurban train testing apparatus. (2,200 words & fig.)

**1906** **624. (01**  
Street Railway Journal, No. 11, September 15, p. 398.

SCHNEIDER (C. C.). — Bridges for electric railways. (5,500 words, tables & fig.)

**Tramway & Railway World.** (London.)

**1906** **656 .211.7**  
Tramway & Railway World, September, p. 247.

Newport transporter bridge. (2,500 words & fig.)

**In Italian.**

**Giornale del genio civile.** (Roma.)

**1906** **721 .9** (01  
Giornale del genio civile, luglio, p. 373.

PANETTI (M.). — Risultati di esperienze sul cemento armato a tensione semplice ed a flessione, con riguardo speciale ai fenomeni che si verificano in seguito allo scaricamento. (3,400 parole.)

**1906** **621 .33**  
Giornale del genio civile, luglio, p. 389.

La trazione elettrica sulle ferrovie Valtellinesi. (1,400 parole.)

**Ingegneria ferroviaria.** (Roma.)

**1906** **621 .33**  
Ingegneria ferroviaria, n° 16, 16 agosto, p. 245.

CROSA (V.). — La trazione elettrica sul tronco di ferrovia Pontedecimo-Busalla. (2,400 parole.)

**1906** **621 .13** (06.4  
Ingegneria ferroviaria, n° 16, 16 agosto, p. 247.

Le locomotive estere. (550 parole & fig.)

**1906** **621 .132.8 & 656 .27**  
Ingegneria ferroviaria, n° 16, 16 agosto, p. 253.

SCOPOLI (E.). — Progetto di un treno economico. (1,600 parole & fig.)

**1906** **625 .2** (06.4  
Ingegneria ferroviaria, n° 17, 1° settembre, p. 267.

CERRETI (U.). — L'esposizione di Milano. — Vagoni postali. (900 parole & fig.)



**In Spanish.**

---

**Gaceta de los caminos de hierro. (Madrid.)**

**1906**

**621 .132.5**

Gaceta de los caminos de hierro, nº 2608, 1º de septiembre, p. 389.

OLIVARES (L. Z.). — La locomotora compound más pequeña del mundo. (1,200 palabras & fig.)

**In Dutch.**

---

**Ingenieur. ('s Gravenhage.)**

**1906**

**625 .1 (.492**

Ingenieur, nº 37, 15 September, p. 671.

Spoorwegen in en rondom Utrecht. (6,000 woorden & fig.)



MONTHLY BIBLIOGRAPHY OF RAILWAYS <sup>(1)</sup>

PUBLISHED UNDER THE SUPERVISION OF

L. WEISSENBRUCH,

Secretary General of the Permanent Commission of the International Railway Congress.

[ 016 .385. (02) ]

## I. — BIBLIOGRAPHY OF BOOKS

(November, 1906.)

## In French.

1906

**HEYNINX** (M.), architecte en chef du service spécial des bâtiments civils.**L'installation des appareils de chauffage et de ventilation dans le bâtiment situé rue Ducale, à Bruxelles, et destiné aux Administrations centrales des postes et de la marine.**

Bruxelles, J. Goemaere. In-8°, 35 pages et IV planches hors texte. (Prix : 2 fr. 50 c.)

1906

**JAUNEZ** (A.).**Manuel du chauffeur.** Guide pratique à l'usage des mécaniciens, chauffeurs et propriétaires de machines à vapeur. Nouvelle édition, augmentée d'une étude sur les nouvelles chaudières multitubulaires par **THIVET** (H.), ingénieur des arts et manufactures.

Paris, Hetzel. In-16, 272 pages, 51 figures. (Prix : 4 francs.)

1905

**RODIER** (H.).**Traction sur routes.** Automobiles, vapeur, pétrole, électricité.

Paris. 1 volume in-4°, 209 pages.

697

1906

**ROESSLER** (G.), professeur à l'école technique supérieure de Dantzig.**Théorie et calcul des lignes à courants alternatifs.** Traduit de l'allemand par **STEINMANN** (E.), professeur à l'école de mécanique de Genève.

Paris, Béranger. 1 volume in-8°, 60 figures dans le texte et 7 planches hors texte. (Prix : 12 francs.)

1906

**STODOLA** (A.), professeur à l'école polytechnique fédérale de Zurich.**Les turbines à vapeur.** Ouvrage suivi de considérations sur les machines thermiques et leur avenir ainsi que sur la turbine à gaz. Traduit d'après la 3<sup>e</sup> édition allemande par **HAHN** (E.), ingénieur, directeur du laboratoire de mécanique appliquée à l'université de Nancy.

Paris, Dunod &amp; Pinat. In-8°, viii-636 pages, 434 figures. (Prix : 25 francs.)

1906

**ZILLICH** (K.), inspecteur des travaux hydrauliques.**La statique appliquée à la résistance des matériaux et aux constructions civiles.** Traduit de l'allemand par **THIBAUT** & **HUBLET** (E.).

Paris, Dunod &amp; Pinat. In-8°, avec figures. (Prix : 12 fr. 50 c.)

621 .336. (01)

621 .2

62. (01)

621 .116. (02)

621 .14

(1) The numbers placed over the title of each book are those of the decimal classification proposed by the Railway Congress conjointly with the Office Bibliographique International, of Brussels. (See "Bibliographical Decimal Classification as applied to Railway Science," by L. WEISSENBRUCH, in the number for November, 1897, of the *Bulletin of the International Railway Congress*, p. 1509.)

**N. B. — The Monthly Bibliography is printed on one side only so that it may be cut up into slips and pasted on labels for catalogues and indexes.**



**In German.**

**1906** **621 .33**  
**BERTHOLD (Max).**

**Die Verwaltungspraxis bei Elektrizitätswerken und elektrischen Strassen- und Kleinbahnen.**

Berlin, Julius Springer. In-8°. (Preis : 8 Mark.)

**1906** **385 .1 (.431)**  
**BIEDERMANN (E.),** Königl. Eisenbahn-Bau- und Betriebsinspektor in Magdeburg.

**Die wirtschaftliche Entwicklung der preussischen Staatseisenbahnen, veranschaulicht in Tabellen und graphischen Darstellungen.**

Berlin, J. Springer, (Preis : 3 Mark.)

**1906** **313 .385 (.43)**  
**GESCHÄFTSFÜHRENDEN VERWALTUNG DES VEREINS.**

**Statistische Nachrichten von den Eisenbahnen des Vereins deutscher Eisenbahn-Verwaltungen für das Rechnungsjahr 1904.**

Berlin. 55. Jahrgang, 273 Seiten in Folio.

**1906** **656 .256**  
**GOLLMER.**  
**Die Blockabsicherungseinrichtung auf den preussischen Staatsbahnen.**

Paris, Dunod & Pinat, In-8°. (Preis : 2 fr. 75 c.)

**1906** **621 .132.8 & 621 .335**  
**HELLER (Arnold),** Ingenieur.  
**Der automobilmotor im Eisenbahnbetriebe.**  
 Leipzig, Richard Carl Schmidt & Co., G. Schönfelds Verlagsbuchhandlung. 82 Abbildungen im Text. (Preis : 2.80 Mark.)

**1906** **691**  
**PROBST (E.),** Ingenieur.  
**Das Zusammenwirken von Beton und Eisen.**  
 Berlin, W. Ernst & Sohn. In-8°, 60 Seiten, 9 Figuren. (Preis : 3 Mark.)

**1906** **625 .171. (02)**  
**SCHUBERT (E.),** Geh. Baur.  
**Katechismus für den Bahnwärter-Dienst.** Nach den neuesten Vorschriften ergänzt durch Reg.- und Baur. R. v. ZABIENSKY.  
 Wiesbaden, J. F. Bergmann. 11. Auflage. In-8°, vii-148 seiten mit 102 Abbildungen. (Preis : 1.60 Mark.)

**1906** **656 .257. (02)**

**SCHUBERT (E.),** Geh. Baur.

**Katechismus für den Weichenstellerdienst.** Ein Lehr- und Nachschlagebuch für Stellwerkswärter, Weichensteller, Hilfsweichensteller und Rottenführer. Nach den neuesten Vorschriften ergänzt durch Reg.- und Baur. R. v. ZABIENSKY.

Wiesbaden, J. F. Bergmann. In-8°, viii-176 Seiten mit 101 Abbildungen. (Preis : 1.60 Mark.)

**1906** **721 .9 (01)**  
**SCHUELE.**

**Resultate der Untersuchung von armierten Beten auf reine Zugfestigkeit.**

Paris, Dunod & Pinat. In-8°. (Preis : 13 fr. 75 c.)

**In English.**

**1906** **621 .14 (02)**  
**AUTOMOBILE CLUB & MOTOR UNION OF GREAT BRITAIN & IRELAND.**

**The automobile handbook, 1906.**

London, P. S. King & Son. (Price : 3s.)

**1906** **624. (01)**  
**BUEL (Albert W.).**  
**General specifications for steel railroad bridges and structures.** With a section making them applicable to highway bridges and buildings.

New York, The Engineering News Publishing Company. (8 3/4 × 6 inches), 61 pages, diagrams and tables. (Price : 50 cents.)

**1906** **62. (02)**  
**CARPENTER (Rolla Clinton).**

**Experimental engineering and manual for testing; for engineers and for students in engineering laboratories.**

New York, John Wiley & Sons. Sixth edition, 8vo cloth, 19 + 843 pages, illustrations, diagrams. (Price : \$6.)

**1906** **624. (01)**  
**COOPER (Theodore),** consulting engineer.  
**General specifications for steel railroad bridges and viaducts.**

New York, The Engineering News Publishing Company. (9 1/2 × 7 inches), 36 pages. (Price : 50 cents.)

**1906** **385 .15**  
**CUNNINGHAM (W.).**

**Should our railways be nationalised?**

Dunfermline, A. Romanes & Son, Press Office. Fourth edition, (8 1/2 × 5 1/2 inches), 295 pages. (Price : 2s. 6d.)



906 621 .336  
**MICHALKE** (Dr. Carl).  
*Stray currents from electric railways.* Translated by Otis Allen KENYON.  
 New York, McGraw Publishing Company. (8 × 5 1/2 inches), 61 pages, 34 illustrations. (Price : \$1.50.)

906 621 .13 (06)  
**RAILWAY MASTER MECHANIC'S ASSOCIATION.**  
*Report of the proceedings of the thirty-ninth annual convention held at Atlantic City, N. J., June 18, 19 and 20, 1906.*  
 Chicago, The Henry O. Shepard Company. 8vo cloth, 70 pages.

906 656 .28 (01)  
**RICHARDS** (R. C.).  
*Railroad accidents, their cause and prevention.*  
 Chicago, Association of Railway Claim Agents. (7 × 4 1/2 inches), 111 pages. (Price : \$1.)

906 385 .14 (.73)  
**SMALLEY** (Harrison Standish).  
*Railroad rate control in its legal respects : a study of the effect of judicial decisions upon public regulation of railroad rates.*  
 New York, Macmillan. 8vo cloth. 147 pages. (Price : \$1.)

**In Italian.**

1906 62. (02)  
**CARIATI** (G.).  
*Manuale dell' ingegnere civile e dell' architetto.*  
 Turino, F. Casanova e C. Terza ristampa. In-16, xxiv-860 pagine.

1906 62. (02)  
*Trattato generale teorico-pratico dell' arte dell' ingegnere civile, industriale ed architetto.*  
 Milano, F. Vallardi. Fasc. 122-123, in-8°, 1-64 pagine.

1906 721 .9 (02)  
**VACCHELLI** (Gius.), ing.  
*Le costruzioni in calcestruzzo ed in cemento armato.*  
 Milano, U. Hoepli (M. Bellinzaghi). Terza edizione. In-16°, xvj-383 pagine, fig.



## II. — BIBLIOGRAPHY OF PERIODICALS

(October, 1906.)

## In French.

**Annales des mines. (Paris.)**

**1906** 669 .1 (.42)  
 Annales des mines, juin, p. 722.

BERNHEIM (E.). — L'unification des profils et des spécifications techniques en Grande-Bretagne. (5,400 mots.)

**Annales des ponts et chaussées. (Paris.)**

**1906** 624. (01)  
 Annales des ponts et chaussées, 2<sup>e</sup> trimestre, p. 235.

BIETTE (L.). — Déplacement de la passerelle de Passy. (4,000 mots, 1 tableau & fig.)

**1906** 625 .111  
 Annales des ponts et chaussées, 2<sup>e</sup> trimestre, p. 255.

FARID-BOULAD. — Application de la méthode des points alignés au tracé des paraboles de degré quelconque. (2,700 mots & fig.)

**1906** 313 .385 (.82)  
 Annales des ponts et chaussées, juin, p. 564.

Résultats généraux de l'exploitation des chemins de fer de la République Argentine pendant les années 1903 et 1902. (6 tableaux.)

**1906** 313 .385 (.436 + .439)  
 Annales des ponts et chaussées, juin, p. 568.

Résultats généraux de l'exploitation des chemins de fer d'Autriche-Hongrie pendant les années 1903 et 1902. (5 tableaux.)

**1906** 313 .385 (.41 + .42)  
 Annales des ponts et chaussées, juin, p. 570.

Résultats généraux de l'exploitation des chemins de fer du Royaume-Uni de Grande-Bretagne et d'Irlande pendant les années 1904 et 1903. (9 tableaux.)

**Annales des travaux publics de Belgique. (Bruxelles.)**

**1906** 694  
 Annales des travaux publics de Belgique, octobre, p. 1009.

DENIL (G.). — La défense des charpentes en métal contre la rouille. (36,000 mots, tableaux & fig.)

**1906** 624. (01)  
 Annales des travaux publics de Belgique, octobre, p. 1127.

VIERENDEEL (A.). — Pièces chargées debout. — Théorie nouvelle. (8,500 mots, 1 tableau & fig.)

**Bulletin du Congrès international des chemins de fer. (Bruxelles.)**

**1906** 625 .216  
 Bulletin du Congrès des chemins de fer, n° 10, octobre, p. 1141.

DOYEN (J.). — Les tampons de choc dans les manœuvres et dans les freinages des trains longs. (1,600 mots & fig.)

**1906** 621 .134.3  
 Bulletin du Congrès des chemins de fer, n° 10, octobre, p. 1149.

L'emploi de la vapeur surchauffée sur le « Canadian Pacific Railway ». (4,800 mots & 3 tableaux.)

**1906** 725 .31  
 Bulletin du Congrès des chemins de fer, n° 10, octobre, p. 1158.

La nouvelle gare du « Pennsylvania Railroad » à New-York. (1,800 mots & fig.)

**1906** 621 .33  
 Bulletin du Congrès des chemins de fer, n° 10, octobre, p. 1165.

MÜLLER (W. A.). — Les chemins de fer et tramways électriques de la Suisse. (7,700 mots, 5 tableaux & fig.)

**1906** 385. (09.1 (.54)  
 Bulletin du Congrès des chemins de fer, n° 10, octobre, p. 1189.

BLUM & GIESE (E.). — Le service des voyageurs sur les chemins de fer de Ceylan. (2,400 mots, 2 tableaux & fig.)

**1906** 656. 23  
 Bulletin du Congrès des chemins de fer, n° 10, octobre, p. 1197.

Trafic suburbain (question XII, 7<sup>e</sup> session). Discussion. (12,700 mots.)

**1906** 656 .235  
 Bulletin du Congrès des chemins de fer, n° 10, octobre, p. 1225.

Tarification des marchandises à petite vitesse (question XIII, 7<sup>e</sup> session). Discussion. (15,500 mots.)



**1906** 656 .235 (.54)  
Bulletin du Congrès des chemins de fer, n° 10, octobre, p. 1257.

DRING (William A.). — Tarification des marchandises à petite vitesse (question XIII, 7<sup>e</sup> session). Note sur la tarification des marchandises sur les chemins de fer des Indes anglaises. Annexe à la discussion. (4,300 mots.)

**1906** 625 .242  
Bulletin du Congrès des chemins de fer, n° 10, octobre, p. 1265.

Wagon de 30 tonnes, pour minerai de fer, du « North Eastern Railway ». (2,000 mots & fig.)

**1906** 625 .245  
Bulletin du Congrès des chemins de fer, n° 10, octobre, p. 1272.

Wagon de 40 tonnes pour le transport des pièces pondéreuses. (250 mots & fig.)

**1906** 625 .216  
Bulletin du Congrès des chemins de fer, n° 10, octobre, p. 1272.

Appareil d'attelage à friction et support latéral avec pièce basculante construits par la « Cardwell Manufacturing Company », à Chicago. (600 mots & fig.)

**1906** 621 .133.7  
Bulletin du Congrès des chemins de fer, n° 10, octobre, p. 1275.

L'écope à eau du « Great Eastern Railway ». (500 mots & fig.)

**1906** 656 .215  
Bulletin du Congrès des chemins de fer, n° 10, octobre, p. 1278.

L'éclairage de « Victoria Station ». (600 mots & fig.)

**1906** 656 .211.5  
Bulletin du Congrès des chemins de fer, n° 10, octobre, p. 1279.

Auvents-papillons pour quais à voyageurs du « New York Central ». (350 mots & fig.)

**1906** 385 .(09.2  
Bulletin du Congrès des chemins de fer, n° 10, octobre, p. 1282.

Nécrologie : Francis William Wzbb. (750 mots.)

**1906** 016 .385. (02  
Bulletin du Congrès des chemins de fer, n° 10, octobre, p. 99.

Bibliographie mensuelle des chemins de fer. — Livres. (7 fiches.)

**1906** 016 .385. (05  
Bulletin du Congrès des chemins de fer, n° 10, octobre, p. 100.

Bibliographie mensuelle des chemins de fer. — Périodiques. (105 fiches.)

**Bulletin de la Société des Ingénieurs civils de France. (Paris.)**

**1906** 625 .3  
Bulletin de la Soc. des ing. civ. de France, n° 6, juin, p. 917.

MALLET (A.). — Traction sur crémaillère ou par adhérence. (5,200 mots & 10 tableaux.)

**Bulletin des transports internationaux par chemins de fer. (Bern.)**

**1906** 385 .63  
Bulletin des transports intern. par ch. de fer, n° 10, oct., p. 347.

Deuxième convention additionnelle à la convention internationale du 14 octobre 1890 sur le transport de marchandises par chemins de fer. (9,500 mots.)

**Éclairage électrique. (Paris.)**

**1906** 621 .33  
Éclairage électrique, n° 39, 29 septembre, p. 486.  
— n° 40, 6 octobre, p. 13.

SOLIER (A.). — Installations de traction électrique au Simplon. (4,500 mots & fig.)

**1906** 621 .33 (.45)  
Éclairage électrique, n° 42, 20 octobre, p. 96.

SOLIER (A.). — Tramways électriques des environs de Rome. (1,000 mots & fig.)

**Génie civil. (Paris.)**

**1906** 624 .61  
Génie civil, n° 1268, 29 septembre, p. 337.

DUMAS (A.). — Nouveau pont en maçonnerie, sur la Loire à Orléans. (7,500 mots, 3 tableaux & fig.)

**1906** 621 .132.3  
Génie civil, n° 1270, 13 octobre, p. 385.

Locomotive d'express de 2,500 chevaux, des ateliers Maffei. (400 mots & fig.)

**1906** 625 .13  
Génie civil, n° 1271, 20 octobre, p. 400.

La ventilation mécanique du tunnel de Cochem (Prusse). (800 mots & fig.)

**Journal des transports. (Paris.)**

**1906** 625 .61 (01  
Journal des transports, n° 38, 22 septembre, p. 445.

Les chemins de fer économiques. (2,000 mots.)



**1906** 625 .236  
**Journal des transports**, n° 39, 29 septembre, p. 461.  
 Le nettoyage pneumatique des wagons. (700 mots.)

**1906** 624 .33 (.73)  
**Journal des transports**, n° 39, 29 septembre, p. 463.  
 Les chemins de fer électriques aux États-Unis. (900 mots & 4 tableaux.)

**1906** 656 .235.7  
**Journal des transports**, n° 41, 13 octobre, p. 481.  
 Questions d'emballages. — Le concours de Marseille. (2,300 mots.)

**1906** 385 .517 (.44)  
**Journal des transports**, n° 42, 20 octobre, p. 493.  
 Les institutions de prévoyance des chemins de fer français. (900 mots & 1 tableau.)

**1906** 621 .14 & 621 .33  
**Journal des transports**, n° 43, 27 octobre, p. 511.  
 Exploitation par automobile et par tramway. (1,500 mots & tableaux.)

**Portefeuille économique des machines. (Paris.)**  
**1906** 625 .231 & 625 .232  
 Portefeuille économique des machines, n° 610, octobre, p. 150.  
 Wagon à bagages avec compartiment postal du chemin de fer du Gothard. (1,000 mots & fig.)

**Revue générale des chemins de fer et des tramways. (Paris.)**  
**1906** 625 .233  
 Revue générale des chemins de fer, n° 4, octobre, p. 215.  
 BIARD (E.) & MAUCLÈRE (G.). — Note sur l'éclairage au gaz à incandescence des voitures à voyageurs d'après les résultats obtenus à la compagnie des chemins de fer de l'Est. (9,900 mots, 1 tableau & fig.)

**1906** 621 .131.1  
 Revue générale des chemins de fer, n° 4, octobre, p. 241.  
 MAISON (F.). — Influence de l'effort de traction sur la répartition de la charge des locomotives. (7,000 mots & fig.)

**1906** 313 .385 (.61)  
 Revue générale des chemins de fer, n° 4, octobre, p. 256.  
 Statistique des chemins de fer algériens et tunisiens, année 1903. (7 tableaux.)

**1906** 385 .113 (.65)  
 Revue générale des chemins de fer, n° 4, octobre, p. 261.  
 COLSON (C.). — Revue des questions de transports. — Les chemins de fer algériens en 1905. (3,500 mots & 2 tableaux.)

**1906** 625 .6 (.44)  
 Revue générale des chemins de fer, n° 4, octobre, p. 266.  
 COLSON (C.). — Revue des questions de transports. — Les chemins de fer et les tramways urbains en 1905. (2,500 mots & 1 tableau.)

**1906** 385 .113 (.44)  
 Revue générale des chemins de fer, n° 4, octobre, p. 270.  
 Les chemins de fer français en 1905. (5,600 mots.)

**Revue de mécanique. (Paris.)**

**1906** 621 .1 (01)  
 Revue de mécanique, n° 2, août, p. 105.  
 BAUERMEISTER (A.). — De l'influence des masses en mouvement dans la machine à vapeur. (5,200 mots & fig.)

**1906** 621 .112 & 621 .114  
 Revue de mécanique, n° 3, septembre, p. 247.  
 BAUERMEISTER (A.). — Influence de la vapeur à haute surchauffe sur le graissage et la déformation des distributions. (3,500 mots, 1 tableau & fig.)

**In German.**

**Annalen für Gewerbe und Bauwesen. (Berlin.)**  
**1906** 621 .135. (01)  
 Annalen für Gewerbe und Bauw., N° 704, 15. Oktober, p. 141.  
 DENECKE (O.). — Der Lokomotivrahmen als starrer Balken auf federnden Stützen. (2,400 Wörter & Fig.)

**Österreichische Eisenbahn-Zeitung. (Wien.)**  
**1906** 656 .25 (01)  
 Österreichische Eisenbahn-Zeitung, N° 26, 1. Oktober, p. 237.  
 BOSSHARDT (V. C.). — Die neuen Verkehrs- und Signalvorschriften. (4,200 Wörter.)

**1906** 621 .33  
 Österreichische Eisenbahn-Zeitung, N° 28, 15. Oktober, p. 261.  
 Die elektrische Bahn Murnau-Oberammergau. (700 Wörter & Fig.)



**Elektrische Bahnen und Betriebe.**  
**Zeitschrift für Verkehrs- und Transportwesen.**  
(München.)

**1906** **621 .33** (09.1 (.43)  
Elektrische Bahnen und Betriebe, Nr 25, 4. September, p. 469.  
— — Nr 28, 4. Oktober, p. 530.

**RINKEL (R.).** — Die Rheinuferbahn Köln-Bonn.  
(4,000 Wörter & Fig.)

**Organ für die Fortschritte des Eisenbahn-  
wesens in technischer Beziehung.** (Wiesbaden.)

**1906** **621 .133.2**  
Organ für die Fortschritte des Eisenbahnw., 9. Heft, p. 169.

**MAYR.** — Feuerbüchsen-Rohrwände aus Kupfer und  
Flusseisen. (1,300 Wörter & Fig.)

**1906** **625 .154**  
Organ für die Fortschritte des Eisenbahnw., 9. Heft, p. 171.

**Auswechselung der Träger der Drehöffnung in der  
Brücke über die Elbe bei Wittenberge.** (700 Wörter  
& Fig.)

**1906** **621 .3**  
Organ für die Fortschritte des Eisenbahnw., 9. Heft, p. 176.

**FRÄNKEL (E.).** — Die augenblicklichen Aufgaben  
der Electrotechnik im Eisenbahnwesen. (700 Wörter.)

**1906** **621 .133.** (01  
Organ für die Fortschritte des Eisenbahnw., 9. Heft, p. 177.

**BUSSE (O.).** — Über die Verdampfungsfähigkeit von  
Lokomotivkesseln. (550 Wörter.)

**1906** **625 .143.5**  
Organ für die Fortschritte des Eisenbahnw., 9. Heft, p. 177.

**Schwellenschraube von Lakhovsky.** (600 Wörter  
& Fig.)

**1906** **725 .33**  
Organ für die Fortschritte des Eisenbahnw., 9. Heft, p. 179.

**SCHÄFER (C. P.).** — Wasserkran für 10 cbm Leistung  
in der Minute. (1,200 Wörter, 1 Tabelle & Fig.)

**1906** **621 .138.5 & 625 .26**  
Organ für die Fortschritte des Eisenbahnw., 9. Heft, p. 180.

**Neue Werkstätten der Louisville und Nashville Eisen-  
bahn.** (1,200 Wörter & Fig.)

**1906** **621 .134.3**  
Organ für die Fortschritte des Eisenbahnw., 9. Heft, p. 182.

**Heissdampflokomotiven.** (500 Wörter, 4 Tabellen  
& Fig.)

**Schweizerische Bauzeitung.** (Zürich.)

**1906** **625 .13**  
Schweizerische Bauzeitung, Nr 12, 22. September, p. 141.

**BRANDAU (K.).** — Die Zweitunnel-Baumethode.  
(2,500 Wörter & Fig.)

**1906** **621 .335.** (01  
Schweizerische Bauzeitung, Nr 13, 29. September, p. 159.

**KUMMER (W.).** — Messresultate und Betriebser-  
fahrungen an der Einphasenwechselstromlokomotive  
mit Kollektormotoren auf der Normalbahnstrecke See-  
bach-Wettingen. (1,600 Wörter & Fig.)

**1906** **625 .232**  
Schweizerische Bauzeitung, Nr 15, 13. Oktober, p. 182.

**Die Speisewagen der Montreux-Berner-Oberland-Bahn.**  
(700 Wörter & Fig.)

**Zeitschrift für Kleinbahnen.** (Berlin.)

**1906** **313 : 625 .6** (.494)  
Zeitschrift für Kleinbahnen, Heft 9, September, p. 590.

**Die schweizerischen Kleinbahnen in den Jahren 1903  
und 1904.** (Tabellen.)

**1906** **621 .33 & 625 .4**  
Zeitschrift für Kleinbahnen, Heft 10, Oktober, p. 669.

**Die Bostoner Hoch- und Tiefbahnen.** (1,400 Wörter  
& Fig.)

**Zeitschrift des Vereines deutscher Ingenieure.**  
(Berlin.)

**1906** **621 .12 & 656 .211.7**  
Zeit. des Vereines deutsch. Ingen., Nr 36, 8. Septemb., p. 1441.

— — Nr 38, 22. — p. 1545.

**Der belgische Turbinen-Postdampfer « Princesse  
Élisabeth ».** (9,000 Wörter, 1 Tabelle & Fig.) (S. *Bulletin  
du Congrès des chemins de fer*, n° 2, février 1906.)

**1906** **621 .132.5**  
Zeit. des Vereines deutsch. Ingen., Nr 38, 22. Septemb., p. 1553.

**Kurvenbewegliche Lokomotiven.** (1,700 Wörter &  
Fig.)

**1906** **656 .212.6**  
Zeit. des Vereines deutscher Ingen., Nr 40, 6. Oktober, p. 1605.

**BÖTTCHER (A.).** — Hammerwippkran für 150t  
grösste Last. (3,000 Wörter, 3 Tabellen & Fig.)

**1906** **656 .211 & 656 .212**  
Zeit. des Vereines deutsch. Ingen., Nr 40, 6. Oktober, p. 1615.

**GIESE (E.) & BLUM.** — Die Anlagen der Pittsburg  
und Lake Erie-Eisenbahn in Pittsburg. (3,000 Wörter,  
1 Tabelle & Fig.)



**Zeitung des Vereins deutscher Eisenbahn-  
verwaltungen. (Berlin)**

1906 656 .222.1 (.73)

Zeitung des Vereins, N<sup>o</sup> 67, 1. September, p. 1049.

Der Empire State Expresszug. (3,500 Wörter, 1 Tabelle & Fig.)

1906 385 .517.6

Zeitung des Vereins, N<sup>o</sup> 73, 22. September, p. 1139.

— N<sup>o</sup> 74, 26. — p. 1153.

REISEWITZ. — Die wissenschaftlichen Kurse über den Alkohol. (6,500 Wörter.)

1906 656 .237

Zeitung des Vereins, N<sup>o</sup> 74, 26. September, p. 1151.

KREFTER (A.). — Über Vereinfachungen in der Stations- und Güterkassenbuchführung auf Bahnhöfen von geringerem Verkehrsumfange. (1,200 Wörter & 2 Tabellen.)

1906 656 .259

Zeitung des Vereins, N<sup>o</sup> 75, 29. September, p. 1167.

MAAS GEESTERANUS (H. P.). — Ein neuer Apparat zur Überwachung der Geschwindigkeit von Eisenbahnzügen. (1,600 Wörter & Fig.)

1906 385 .3 (.73)

Zeitung des Vereins, N<sup>o</sup> 76, 3. Oktober, p. 1183.

LEYNEN (Dr. A. v. D.). — Die novelle vom 29. Juni 1906 zum Bundesverkehrsgesetz (Interstate Commerce Act) der Vereinigten Staaten von America vom 4. Februar 1887. (4,000 Wörter.)

1906 656 .2 (01)

Zeitung des Vereins, N<sup>o</sup> 77, 6. Oktober, p. 1199.

Der Entwurf einer neuen deutschen Verkehrsordnung. (3,000 Wörter.)

1906 656 .222.1 (.73)

Zeitung des Vereins, N<sup>o</sup> 78, 10. Oktober, p. 1220.

Nochmals der Empire State Express. (1,700 Wörter & 1 Tabelle.)

1906 625 .4

Zeitung des Vereins, N<sup>o</sup> 79, 13. Oktober, p. 1231.

BERDROW (W.). — Nochmals die Schwebbahn in Berlin. (1,800 Wörter & Fig.)

**Zentralblatt der Bauverwaltung. (Berlin.)**

1906 624. (01)

Zentralblatt der Bauverwaltung, N<sup>o</sup> 72, 5. September, p. 455.

LEIBBRAND. — Fortschritte im Bau weitgespannter flacher massiver Brücken. (3,600 Wörter.)

**In English.**

**American Engineer  
and Railroad Journal. (New York.)**

1906 621 .132.5

American Engineer & R. Journal, No. 10, October, p. 371.

Mallet articulated compound locomotive, type 2 6-6 2. (2,000 words, 1 table & fig.)

**Bulletin of the International Railway Congress.  
(Brussels.)**

1906 625 .61 (.42)

Bulletin of the Railway Congress, No. 10, October, p. 1493.

GLENDENNING (Seymour). — Burton and Ashby Light Railway. (2,500 words & fig.)

1906 625 .143.3

Bulletin of the Railway Congress, No. 10, October, p. 1500.

MOYLE (G.). — Roaring rails. A mysterious development. (2,300 words & fig.)

1906 656 .256.3 & 625 .4

Bulletin of the Railway Congress, No. 10, October, p. 1507.

Automatic signalling on the underground railways of London. (7,800 words & fig.)

1906 725 .31

Bulletin of the Railway Congress, No. 10, October, p. 1527.

The Pennsylvania Railroad's extension to New York and Long Island. (1,850 words & fig.)

1906 385 .63. (04)

Bulletin of the Railway Congress, No. 10, October, p. 1534.

Second conference for the revision of the international convention on the transport of goods by railway. (7,700 words.)

1906 656 .256.3

Bulletin of the Railway Congress, No. 10, October, p. 1547.

Automatic block-system (question X, 7<sup>th</sup> session). Discussion. (13,900 words.)

1906 656 .256.3

Bulletin of the Railway Congress, No. 10, October, p. 1577.

PLATT (C. H.). — Automatic block-system (question X, 7<sup>th</sup> session). Supplement to report No. 1. Appendix to the discussion. (2,500 words, 8 tables & fig.)

1906 656 .226

Bulletin of the Railway Congress, No. 10, October, p. 1595.

Baggage and express parcels (question XI, 7<sup>th</sup> session). Discussion. (13,500 words.)



**1906** **385 .57**  
Bulletin of the Railway Congress, No. 10, October, p. 1624.

**ARTHURTON** (Alfred W.). — How railwaymen are  
trained : The Great Western Railway Lecture and  
Debating Society. (3,400 words.)

**1906** **625 .245**  
Bulletin of the Railway Congress, No. 10, October, p. 1631.

**40-ton wagon** for the conveyance of boilers, large  
castings and heavy machinery over the Cheshire lines  
system. (200 words & fig.)

**1906** **625 .216**  
Bulletin of the Railway Congress, No. 10, October, p. 1632.

**The Cardwell friction draft gear and rocker side  
bearing.** (650 words & fig.)

**1906** **621 .133.7**  
Bulletin of the Railway Congress, No. 10, October, p. 1634.

**Tender water scoop, Great Eastern Railway.** (650  
words & fig.)

**1906** **656 .215**  
Bulletin of the Railway Congress, No. 10, October, p. 1638.

**The lighting of Victoria station.** (600 words & fig.)

**1906** **656 .281**  
Bulletin of the Railway Congress, No. 10, October, p. 1639.

**The Salisbury railway accident.** (1,500 words.)

**1906** **385. (09.2)**  
Bulletin of the Railway Congress, No. 10, October, p. 1642.

**Obituary : Francis William WEBB.** (700 words.)

**1906** **621 .13 & 385. (04)**  
Bulletin of the Railway Congress, No. 10, October, p. 1644.

**New books and publications : La locomotive actuelle.**  
Étude générale sur les types récents de locomotives à  
grande puissance. Complément au traité pratique de la  
machine-locomotive. (The present locomotive. General  
study of recent types of high-power locomotives. Supple-  
ment to the practical treatise on the locomotive engine).  
by Maurice DEMOULIN. (1,400 words.)

**1906** **016 .385. (02)**  
Bulletin of the Railway Congress, No. 10, October, p. 99.

**Monthly bibliography of railways. — Books.** (7 la-  
bels.)

**1906** **016 .385. (05)**  
Bulletin of the Railway Congress, No. 10, October, p. 100.

**Monthly bibliography of railways. — Periodicals.**  
(105 labels.)

A.

**Engineer. (London.)**

**1906** **621 .132.3**  
Engineer, No. 2645, September 7, p. 235.

**Modern locomotive construction in Belgium.** (3,000  
words & fig.)

**1906** **621 .132.3**  
Engineer, No. 2648, September 28, p. 311.

**" Adriatic " compound locomotive, State Railways of  
Italy.** (1,800 words & fig.)

**1906** **656 .281**  
Engineer, No. 2648, September 28, p. 323 et 326.

**The Grantham accident.** (3,200 words & fig.)

**1906** **621 .132.1 (.73)**  
Engineer, No. 2649, October 5, p. 338.

**Standardising locomotives on the American railways.**  
(3,500 words & 1 table.)

**1906** **656 .222.1**  
Engineer, No. 2649, October 5, p. 341.

**ROUS-MARTEN (C.). — Latest express engines,**  
South Eastern and Chatham Railway. (2,000 words.)

**1906** **656 .281**  
Engineer, No. 2649, October 5, p. 353.

**The Salisbury accident.** (5,500 words, 1 table & fig.)

**1906** **621 .132.8**  
Engineer, No. 2650, October 12, p. 380.

**Bavarian rail motor-coach.** (800 words, 1 table & fig.)

**Engineering. (London.)**

**1906** **624. (01)**  
Engineering, No. 2123, September 7, p. 307.

**BAMFORD (H.). — Moving-loads on railway under-  
bridges.** (1,800 words & fig.)

**1906** **625 .616**  
Engineering, No. 2123, September 7, p. 319.

**Railway motor-carriage (760 millimetre-gauge); Milan  
exhibition.** (650 words, 1 table & fig.)

**1906** **656 .257**  
Engineering, No. 2126, September 28, p. 417.

**Operation of railway points and signal by power.**  
(2,200 words.)

**1906** **621 .132.3**  
Engineering, No. 2126, September 28, p. 422.  
— No. 2127, October 5, p. 457.

**Four-cylinder six-coupled locomotive at the Milan  
exhibition.** (1,700 words & fig.)



**1906** **656 .281**  
Engineering, No. 2126, September 28, p. 431.  
The railway accident at Grantham. (3,600 words & fig.)

**1906** **621 .132.3**  
Engineering, No. 2128, October 12, p. 488.  
HANBURY (H. W.). — Compound locomotive for the Northern Railway of France. (1,800 words & fig.)

**Engineering Magazine. (London.)**

**1906** **621 .7**  
Engineering Magazine, October, p. 21.  
JACOBS (H. W.). — Organization and economy in the railway machine shop. (3,000 words & fig.)

**Engineering News. (New York.)**

**1906** **624 .63**  
Engineering News, No. 2, August 30, p. 215.  
A reinforced concrete arch bridge build in reinforced concrete forms without centering. (2,800 words & fig.)

**1906** **385. (09.1 (.42)**  
Engineering News, No. 9, August 30, p. 218.  
WILSON (H. R.). — British railway methods and management with special reference to safety in operation. (7,000 words.)

**1906** **625 .13**  
Engineering News, No. 11, September 13, p. 272.  
Lowering the tunnels under the Chicago River. (3,200 words & fig.)

**1906** **624. (01**  
Engineering News, No. 11, September 13, p. 278.  
KIRKHAM (J. E.). — Equivalent uniform live loads for railroad bridge trusses. (800 words & fig.)

**1906** **621 .94**  
Engineering News, No. 11, September 13, p. 280.  
High-speed tools for rapid work in turning locomotive driving-wheel tires (550 words & fig.)

**1906** **656 .211.4**  
Engineering News, No. 12, September 20, p. 297.  
HURLBUT (C. C.). — The new terminal station and ferryhouse of the Delaware, Lackawanna & Western R. R. at Hoboken, N. J. (6,000 words & fig.)

**1906** **625 .14 (01**  
Engineering News, No. 12, September 20, p. 310.  
Track construction for railway tunnels. (3,500 words & fig.)

**1906** **625 .14 (01**  
Engineering News, No. 12, September 20, p. 314.  
Track construction and maintenance in railway tunnels. (2,200 words.)

**1906** **621 .331 & 621 .338**  
Engineering News, No. 13, September 27, p. 322.  
The rotary converter substations and electric car equipment of the Long Island Railroad. (4,000 words & fig.)

**1906** **621 .138.3**  
Engineering News, No. 14, October 4, p. 354.  
The care of locomotive boilers at terminals and while in service. (2,800 words.)

**Institution of Mechanical Engineers. (London.)**

**1906** **621 .133.3**  
Institut. of Mechanical Engineers, No. 2, March-May, p. 165.  
CHURCHWARD (G. J.). — Large locomotive boilers. (26,500 words, tables & fig.)

**1906** **621 .133.1**  
Institut. of Mechanical Engineers, No. 2, March-May, p. 265.  
GREAVEN (L.). — Petroleum fuel in locomotives on the Tehuantepec National Railroad of Mexico. (12,000 words, tables & fig.)

**Journal of the Franklin Institute. (Philadelphia.)**

**1906** **621 .116**  
Journal of the Franklin Institute, No. 3, September, p. 201.  
ELDRED (B.). — Regulation of the duration of combustion. (3,300 words, 1 table & fig.)

**Locomotive Firemen's Magazine. (Indianapolis.)**

**1906** **621 .137.1**  
Locomotive Firemen's Magazine, October, p. 463.  
The Hayden mechanical stoker. (3,000 words & fig.)

**1906** **625 .13**  
Locomotive Firemen's Magazine, October, p. 473.  
Ventilation of the Interborough Subway, New York. (5,600 words.)



**Locomotive Journal. (Leeds.)**

- 1906** **625 .13**  
Locomotive Journal, No. 10, October, p. 477.  
The construction of a new bridge under an existing railway. (2,200 words, 1 table & fig.)

**Proceedings of the American Society of Civil Engineers. (New York.)**

- 1906** **621 .13 & 621 .33**  
Proceed. of the Amer. Soc. of Civil Eng., No. 7, Septemb., p. 643.  
MAYER (J.). — Steam locomotive and electric operation for trunk-line traffic. A comparison of costs and earnings. (13,200 words & fig.)

**Railroad Gazette. (New York.)**

- 1906** **625 .144.4**  
Railroad Gazette, No. 11, September 14, p. 214.  
The Lake Shore gravel ballast washing plants. (1,400 words & fig.)

- 1906** **621 .131.1**  
Railroad Gazette, No. 11, September 14, p. 217.  
RAYMOND (W. G.). — Acceleration, and some locomotive problems. (3,400 words).

- 1906** **624 .63**  
Railroad Gazette, No. 11, September 14, p. 220.  
Strauss ribbed concrete-steel bridge for the Elgin-Belvidere Electric Railroad. (2,200 words & fig.)

- 1906** **656 .222.1**  
Railroad Gazette, No. 12, September 21, p. 237.  
Tonnage rating for locomotives. (1,200 words.)

- 1906** **625 .13**  
Railroad Gazette, No. 12, September 21, p. 246.  
The ventilation of tunnels. (3,600 words & fig.)

- 1906** **656 .259**  
Railroad Gazette, No. 12, September 21, p. 250.  
The Flaman speed indicator. (600 words & fig.)

- 1906** **385. (09 3 (.45)**  
Railroad Gazette, No. 13, September 28, p. 261.  
NORTH (E. P.). — The history and organization of Italian railroads. (1,000 words & fig.)

- 1906** **656 .235. (01 (.73)**  
Railroad Gazette, No. 13, September 28, p. 266.  
Economic wastes in transportation. (6,500 words.)

A.

- 1906** **621 .132.8**  
Railroad Gazette, No. 14, October 5, p. 289.  
The Kobusch-Wagenhals steam motor car. (500 words & fig.)

- 1906** **621 .33 (09.1 (.73)**  
Railroad Gazette, No. 14, October 5, p. 293.  
The New York Central's terminal electrification at New York. (2,400 words & fig.)

- 1906** **656 .256**  
Railroad Gazette, No. 14, October 5, p. 296.  
Electro-pneumatic block signals on the electrified line of the West Jersey & Seashore. (1,400 words & fig.)

**Railway Age. (Chicago.)**

- 1906** **621 .132.8**  
Railway Age, No. 1577, August 31, p. 254.  
Steam motor car for the Canadian Pacific Railway. (650 words & fig.)

- 1906** **624 .63**  
Railway Age, No. 1577, August 31, p. 258.  
Novel method of concrete bridge construction. (1,600 words & fig.)

- 1906** **621 .132.3**  
Railway Age, No. 1578, September 7, p. 284.  
New locomotives for the Northern Pacific. (1,800 words & fig.)

- 1906** **656 .254**  
Railway Age, No. 1578, September 7, p. 289.  
FOWLE (F. F.). — The traffic of railway communication. (3,500 words & fig.)

- 1906** **656 .211**  
Railway Age, No. 1582, October 5, p. 411.  
The El Paso Union passenger station. (1,200 words & fig.)

- 1906** **385 .14 (.73)**  
Railway Age, No. 1583, October 12, p. 442.  
The commission's hearing on tariffs. (3,000 words.)

**Railway Engineer. (London.)**

- 1906** **621 .132.3**  
Railway Engineer, No. 321, October, p. 307.  
Express goods engine; Caledonian Railway. (300 words & fig.)

21\*



**1906** **625 .244**

Railway Engineer, No. 321, October, p. 317.

20-ton refrigerator Van; London, Brighton and South Coast Railway. (1,000 words & fig.)

---

**Railway and Engineering Review. (Chicago.)**

**1906** **621 .338**

Railway and Engineering Review, No. 35, September 1, p. 668.

SMITH (W. N.). — Steel car equipment on the Long Island R. R. (2,400 words & fig.)

**1906** **621 .138.3**

Railway and Engineering Review, No. 35, Sept. 1, p. 675 et 678.

Care of locomotive boilers. (4,200 words & fig.)

**1906** **625 .13**

Railway and Engineering Review, No. 37, September 15, p. 708.

FRANCIS (G. B.) & DENNIS (W. F.). — Scranton tunnel, Lackawanna & Wyoming Valley R. R. (5,200 words & fig.)

**1906** **625 .232**

Railway and Engineering Review, No. 39, September 29, p. 747.

Southern Pacific all steel coach. 500 words & fig.)

**1906** **621 .132.8**

Railway and Engineering Review, No. 39, September 29, p. 748.

The Kobusch-Wagenhals steam motor coach. (1,000 words & fig.)

**1906** **625 .142.3**

Railway and Engineering Review, No. 39, September 29, p. 751.

Practicability and life of metal cross ties for railroad track construction. (2,000 words.)

**1906** **621 .132.5**

Railway and Engineering Review, No. 40, October 6, p. 768.

New Delaware & Hudson consolidation locomotives. (600 words & fig.)

---

**Railway Gazette. (London.)**

**1906** **621 .131.1**

Railway Gazette, No. 13, September 28, p. 345.

RAYMOND (W. G.). — Acceleration, and some locomotive problems. (3,400 words.)

**1906** **624 .63**

Railway Gazette, No. 13, September 28, p. 348.

Strauss ribbed concrete-steel bridge for the Elgin-Belvidere Electric Railroad. (2,200 words & fig.)

**1906** **656 .281**

Railway Gazette, No. 14, October 5, p. 370.

Board of Trade railway accident report. Salisbury, London & South Western Railway, July 1. (900 words & fig.)

**1906** **621 .7 (.73)**

Railway Gazette, No. 14, October 5, p. 378.

Organization and construction methods used on the Ivorydale shops of the C. H. & D. (2,000 words & fig.)

**1906** **625 .13**

Railway Gazette, No. 14, October 5, p. 382.

The ventilation of tunnels. (3,600 words & fig.)

**1906** **656 .259**

Railway Gazette, No. 14, October 5, p. 386.

The Flaman speed indicator. (600 words & fig.)

**1906** **656 .235. (01 (.73)**

Railway Gazette, No. 15, October 12, p. 410.

Economic wastes in transportation. (6,500 words.)

**1906** **621 .33**

Railway Gazette, No. 16, October 19, p. 437.

The New York Central's terminal electrification at New York. (2,700 words & fig.)

**1906** **656 .256**

Railway Gazette, No. 16, October 19, p. 442.

Electro-pneumatic block signals on the electrified line of the West Jersey & Seashore. (1,300 words & fig.)

---

**Railway and Locomotive Engineering. (New York.)**

**1906** **621 .132.5**

Railway and Locomotive Engineering, October, p. 472.

Baldwin Mallet compound. (1,600 words & fig.)

---

**Railway Machinery. (New York.)**

**1906** **621 .132.3 & 621 .132.5**

Railway Machinery, September, p. 2.

New Northern Pacific Railway locomotives. (1,300 words & fig.)

**1906** **621 .132.3**

Railway Machinery, October, p. 55.

KING (C. R.). — Adriatic type four-cylinder balanced compound locomotive of the Italian State Railways. (3,200 words & fig.)



**Railway Magazine. (London.)**

- 1906** **656 .222.1**  
 Railway Magazine, No. 112, October, p. 363.  
 ROUS-MARTEN (C.). — British locomotive practice and performance. (3,700 words & fig.)

- Railway Maintenance and Structures. (New York.)**  
**1906** **625 .142.2 & 691**  
 Railway Maintenance and Structures, October, p. 216.  
 Experiments on the strength of treated timber. (3,500 words & fig.)

- Railway Master Mechanic. (Chicago.)**  
**1906** **621 .135.1**  
 Railway Master Mechanic, No. 9, September, p. 302.  
 Welding broken locomotive frames without removal. (800 words & fig.)

- Railway Times. (London.)**  
**1906** **621 .338**  
 Railway Times, No. 14, October 6, p. 353.  
 Electrical equipment of steam rolling stock. (1,200 words & fig.)

- 1906** **621 .132.8**  
 Railway Times, No. 17, October 27, p. 425.  
 First rail motor car for the Isle of Wight. (750 words & fig.)

- Railway World. (Philadelphia.)**  
**1906** **625 .142.3**  
 Railway World, No. 40, October 5, p. 847.  
 PORTER (H. T.). — Practicability and life of metal cross ties. (1,500 words.)

- South African Railway Magazine. (Johannesburg.)**  
**1906** **385. (07.1**  
 South African Railway Magazine, No. 2, October, p. 68.  
 BRAAMFONTEIN (J. C.). — The technical training of railroad officers. (3,500 words.)

- 1906** **656 .257**  
 South African Railway Magazine, No. 2, October, p. 80.  
 MOORE (W.). — Power signalling. (1,700 words & fig.)

- Street Railway Journal. (New York.)**  
**1906** **625 .252 & 625 .253**  
 Street Railway Journal, No. 13, September 29, p. 475.  
 GRAHAM (G. C.). — Braking for electric cars. (1,200 words & fig.)

- Tramway & Railway World. (London.)**  
**1906** **625 .25 (01**  
 Tramway & Railway World, October, p. 347.  
 MOZLEY (H.). — Car brakes. (8,500 words, 4 tables & fig.)

**In Italian.**

- Giornale del genio civile. (Roma.)**  
**1906** **385 .11 (.45)**  
 Giornale del genio civile, agosto, p. 432.  
 Quel che hanno costato e quel che rendono le ferrovie in Italia. (4,200 parole.)

- 1906** **621 .33**  
 Giornale del genio civile, agosto, p. 440.  
 Applicazioni di trazione elettrica monofase. (3,500 parole.)

- Ingegneria ferroviaria. (Roma.)**  
**1906** **625 .24 (06.4**  
 Ingegneria ferroviaria, n° 19, 1° ottobre, p. 307.  
 CERRETI (U.). — Carri merci. (1,700 parole & fig.)

- 1906** **621 .13 (06.4**  
 Ingegneria ferroviaria, n° 20, 16 ottobre, p. 318.  
 L'esposizione di Milano. — Locomotive estere. (4,500 parole & fig.)



1906

625.23 (06.4

gegneria ferroviaria, n° 20, 16 ottobre, p. 326.

CERRETI (U.). — Vetture e bagagliai. (2,000 parole  
fig.)

---

**In Spanish.**

---

**Revista de obras públicas. (Madrid.)**

1906

656.222.1

Revista de obras públicas, n° 1622, 25 de octubre, p. 517.

Ensayos recientes de marcha a gran velocidad con  
locomotoras de vapor. (2,500 palabras & cuadros.)

---

1. The first part of the paper discusses the importance of the study of the history of the English language. It is noted that the English language has a long and rich history, and that the study of its history is essential for a full understanding of the language. The paper then discusses the various factors that have influenced the development of the English language, including the influence of other languages, the influence of social and cultural changes, and the influence of technological advances.

# BIBLIOGRAPHIA UNIVERSALIS

COOPERATIVE PUBLICATION OF THE OFFICE BIBLIOGRAPHIQUE INTERNATIONAL, OF BRUSSELS

## MONTHLY BIBLIOGRAPHY OF RAILWAYS <sup>(1)</sup>

PUBLISHED UNDER THE SUPERVISION OF

L. WEISSENBRUCH,

Secretary General of the Permanent Commission of the International Railway Congress.

[ 016 .385. (02) ]

### I. — BIBLIOGRAPHY OF BOOKS

(December, 1906.)

#### In French.

1906 385 .581.1  
**BOISTEL** (Julien), sous-chef de bureau au ministère du commerce, de l'industrie et du travail.

**Manuel pratique pour l'application de la loi sur le repos hebdomadaire.**

Paris, librairie Chaix. (Prix : 1 fr. 50 c.)

1906 351 .812  
**LAMÉ FLEURY** (E.), inspecteur général des mines, & **SARRUT** (Louis), président de Chambre à la Cour de cassation.

**Code annoté des chemins de fer en exploitation ou recueil méthodique et chronologique des lois, décrets, etc., concernant l'exploitation technique et commerciale des chemins de fer.**

Paris, librairie Chaix. 4<sup>e</sup> édition, 1 volume in-8° de plus de 1,200 pages. (Prix : 20 francs.)

1906 313 .385 (.44)  
**MINISTÈRE DES TRAVAUX PUBLICS.**

**Statistique des chemins de fer français au 31 décembre 1904. Documents principaux.**

Melun, Imprimerie administrative. In-4°, vi-573 pages. (Prix : 5 francs.)

1903 313 : 625 .6 (.44)  
**MINISTÈRE DES TRAVAUX PUBLICS.**

**Statistique des chemins de fer français au 31 décembre 1903. Documents divers. 2<sup>e</sup> partie. Intérêt local et tramways.**

Melun, Imprimerie administrative. In-4°, 494 pages. (Prix : 5 francs.)

1906 62. (09.3)  
**PICARD** (Alfred), de l'Institut, commissaire général de l'exposition de 1900.

**Le bilan d'un siècle (1801-1900). T. 2 : Mécanique générale. Électricité. Génie civil et moyens de transport.**

Paris, Imprimerie nationale; librairie Le Soudier. In-8°, 410 pages.

1906 656 .235  
**RAGOT** (Ch.).

**Transports par chemins de fer. Droits et devoirs des expéditeurs et des destinataires. Marchandises (petite et grande vitesse). Colis postaux.**

Poligny, imprimerie Jacquin. In-8°, 48 pages. (Prix : 1 franc.)

(1) The numbers placed over the title of each book are those of the decimal classification proposed by the Railway Congress conjointly with the Office Bibliographique International, of Brussels. (See "Bibliographical Decimal Classification as applied to Railway Science," by L. WEISSENBRUCH, in the number for November, 1897, of the *Bulletin of the International Railway Congress*, p. 1509.)

**N. B. — The Monthly Bibliography is printed on one side only so that it may be cut up into slips and pasted on labels for catalogues and indexes.**



**1906** **621 .336. (01)**  
**ROESSLER** (G.), professeur à l'école technique supérieure de Danzig.

**Théorie et calcul des lignes à courants alternatifs.** Traduit de l'allemand par E. STEINMANN, professeur à l'école de mécanique de Genève.

Paris, Ch. Béranger. 1 volume in-8°, 60 figures dans le texte et 7 planches hors texte. (Prix : 12 francs.)

**1906** **621 .2 (02)**  
**STODOLA** (A.), professeur à l'école polytechnique fédérale de Zurich.

**Les turbines à vapeur.** Ouvrage suivi de considérations sur les machines thermiques et leur avenir ainsi que sur la turbine à gaz. Traduit d'après la 3<sup>e</sup> édition allemande par E. HAHN, directeur du laboratoire de mécanique appliquée à l'université de Nancy.

Paris, Dunod & Pinat. In-8°, VIII-636 pages, 434 figures. (Prix : 25 francs.)

**In German.**

**1906** **621 .33**  
**BERTHOLD** (Max).

**Die Verwaltungspraxis bei Elektrizitätswerken und bei elektrischen Strassen- und Kleinbahnen.**

Berlin, Julius Springer. (Preis : 8 Mark.)

**1906** **385 .4 (.4)**  
**EXNER** (Wilhelm), Sektionschef.

**Studien über die Verwaltung des Eisenbahnwesens mittel-europäischer Staaten.**

Wien, Otto Maass' Söhne.

**1906** **62. (02)**  
**Fehlands Ingenieur Kalender 1907.** Für Maschinen- und Hütteningenieure. Herausgegeben von Prof. Fr. FREYTAG.

Berlin, Julius Springer. 29. Jahrgang, 2 Teile, in-8°, VII-220 und 319 Seiten mit Abbildungen im Text. (Preis : 3 Mark.)

**1906** **669**  
**GOERENS** (Paul), Assistent am Eisenhüttenmännischen Institut der Königlichen Technischen Hochschule zu Aachen.

**Einführung in die Metallographie.**

Halle a/S., Wilhelm Knapp. 185 Seiten mit 158 Abbildungen. (Preis : 10 Mark.)

**1906** **625 .1 (02)**  
**HARTMANN** (M.), Prof.

**Elemente des Eisenbahnbaues.**

Leipzig, J. J. Weber. 300 Abbildungen, 20 Tafeln und 1 Tabelle. (Preis : 6 Mark.)

**1906** **656 .235**  
**HENKEL** (W.), Eisenbahnsekretär.

**Eisenbahn-Gütertarif für Frankfurt-a/M., Offenbach und Hanau.**

**1906** **62. (02)**

**Hausinger von Waldeggs Eisenbahntechniker-Kalender für 1907.** Unter Mitwirkung von Fachgenossen von A. W. MEYER, Regierungs- und Baurat in Allenstein.

Wiesbaden, Verlag von J. F. Bergmann. 34. Neubearbeitung. (Preis : 4 Mark.)

**1906** **624 .6 (02)**

**LASKUS** (A.), Regierungsrat.

**G. Tolkmitt Leitfaden für das Entwerfen und die Berechnung gewölbter Brücken.**

Berlin, Wilhelm Ernst & Sohn. 2. Auflage, in-8°, 105 Seiten mit 37 Abbildungen. (Preis : 5 Mark.)

**1906** **656 .2**

**LOTZ** (Walter), Prof. Dr.

**Verkehrsentwicklung in Deutschland, 1800-1900.**

Leipzig-Berlin, Verlag von B. G. Teubner. 2. Auflage.

**1906** **62. (01)**

**MEHRTENS** (Georg Christoph).

**Vorlesungen über Statik der Baukonstruktionen und Festigkeitslehre.** In 3 Bänden. — 3. Band : Formänderungen und statisch unbestimmte Träger.

Leipzig, Wilhelm Engelmann. In-8°, XIV-478 Seiten, 330 z. T. farbigen Abbildungen im Text. (Preis : 20 Mark.)

**1906** **656 .24**

**RUNDNAGEL**, Dr. jur. Regierungsrat.

**Die Haftung der Eisenbahn für Verlust, Beschädigung und Lieferfristüberschreitung nach deutschem Eisenbahnfrachtrecht.**

Leipzig, Theodor Weicher. (Preis : 6 Mark.)

**1906** **385. (02)**

**SCHARR** (August).

**Deutscher Eisenbahnkalender 1907.**

Berlin, Ad. Bodenburg. 13. Jahrgang, in-8°, 272 Seiten. (Preis : 1 Mark.)

**1906** **621 .1 (02)**

**SEUFERT** (Fr.).

**Anleitung zur Durchführung von Versuchen an Dampfmaschinen und Dampfkesseln.**

Berlin, Julius Springer. 63 Seiten mit 36 Figuren. (Preis : 1.60 Mark.)



**1906** **62.** (02)  
**Stühls Ingenieur-Kalender für Maschinen- und Hütten-  
 techniker, 1907.** Herausgegeben von C. FRANZEN und  
 K. MATHÉR.  
 Essen, G. D. Baedeker. 42. Jahrgang, 2 Teile, in-8°, VII-214  
 und VII-166 Seiten mit Abbildungen. (Preis : 4 Mark.)

**In English.**

**1906** **621 .117.** (02 & **621 .137.1** (02)  
**BALE** (M. Powis).  
**A handbook for steam users :** being rules for engine  
 drivers and boiler attendants.  
 New York, Longmans, Green & Co. Fifth edition, 13 + 121  
 pages, diagrams. (Price : \$1.)

**1906** **621 .13** (09.3)  
**BENNETT** (A. R.), M. I. E. E.  
**Historic locomotives and moving accidents by steam and  
 rail.**  
 London, Cassell & Co. (Price : 2s. 6d.)

**1906** **625 .2** (01)  
**British standard specifications for material used in the  
 construction of railway rolling stock.**  
 London, Lockwood. Folio. (Price : 10s. 6d.)

**1906** **621 .33** (02)  
**DAWSON** (Philip).  
**The engineering and electric traction pocket book.**  
 London, *Engineering*, (6  $\frac{3}{4}$  × 4  $\frac{1}{4}$  × 1  $\frac{3}{4}$  inches), 1,053  
 pages. (Price : 20s.)

**1906** **385 .4**  
**DEWSNUP** (Ernest Ritson).  
**Railway organization and working :** a series of lectures  
 delivered before the railway classes of the university of  
 Chicago.  
 Chicago, University Press. 8vo cloth, 8+498 pages. (Price :  
 \$2.)

**1906** **694.** (02)  
**ELLIS** (G.).  
**Modern practical carpentry for use of workmen, builders,  
 architects, and engineers.**  
 London, Batsford. 8vo (10  $\frac{3}{4}$  × 7  $\frac{1}{4}$  inches), 406 pages,  
 illustrations. (Price : 12s. 6d.)

**1906** **62.** (02)  
**FRANKLIN** (W.).  
**The elements of electrical engineering :** a text-book for  
 technical schools and colleges.  
 New York, Macmillan. 8vo cloth, 13 + 517 pages. (Price :  
 \$4.50.)

**1906** **389**  
**HALLOCK** (William), Ph. D., & **WADE** (Herbert T.).  
**Outlines of the evolution of weights and measures and the  
 metric system.**  
 New York, The Macmillan Co.; London, Macmillan & Co.  
 (Price : 10s.)

**1906** **621 .139**  
**HENDERSON** (George R.).  
**Cost of locomotive operation.**  
 New York, *The Railroad Gazette*. 192 pages. (Price :  
 \$2.50.)

**1906** **62.** (02)  
**IVES** (H. C.) & **HILTS** (H. E.).  
**Manual of field engineering.**  
 New York, John Wiley & Son. Pocket size, 136 pages.  
 (Price : \$1.50.)

**1906** **621 .1** (02)  
**JAMIESON** (A.).  
**Elementary manual on steam and steam engine.**  
 London, Griffin. Eleventh edition, 8vo (7  $\frac{1}{2}$  × 4  $\frac{3}{4}$  inches),  
 370 pages. (Price : 3s. 6d.)

**1906** **621 .1** (02)  
**JAMIESON** (A.).  
**Text-book of steam and steam engines, including turbine  
 boilers.**  
 London, Griffin. Fifteenth edition, 8vo (8 × 5 inches),  
 842 pages. (Price : 10s. 6d.)

**1906** **62.** (02)  
**JAMIESON** (A.).  
**Text-book of applied mechanics and mechanical engineering.**  
 London, Griffin. Fifth edition, vol. 2, 8vo (8 × 5 inches),  
 834 pages. (Price : 12s. 6d.)

**1906** **621 .13** (02)  
**Locomotive dictionary.**  
 London, *The Railway Gazette*. First edition (12 × 8  $\frac{1}{2}$   
 × 1  $\frac{1}{2}$  inches), 5,148 illustrations. (Price : 29s.)

**1906** **62.** (02)  
**"Mechanical world" pocket diary and year book for 1907.**  
 Containing a collection of useful engineering notes, rules,  
 tables and data.  
 Manchester, Emmott & Co. Cloth (6  $\frac{1}{4}$  × 4 inches),  
 399 pages. 72 illustrations in the text, and many tables.  
 (Price : 6d.)



**1906** **656 .25 (06 (.73)**  
**RAILWAY SIGNAL ASSOCIATION.**  
**Digest of proceedings, 1895-1905.**  
 South Bethlehem, Pa., C. Rosenberg, Secy. L. V. R. R.  
 Cloth, 2 volumes (9 1/2 × 6 inches), 557 + 480 pages, folding  
 and other plates, and text illustrations.

**1906** **62. (01)**  
**SLOCUM (S. E.) & HANCOCK (E. L.).**  
**Text-book on the strength of materials.**  
 Boston, Ginn. 8vo, 13 + 314 pages, illustrations. (Price :  
 \$2.)

**1906** **385 .1**  
**WEBB (Walter Loring).**  
**Economics of railway construction.**  
 New York, John Wiley & Sons. (8 1/4 × 5 1/2 inches), cloth,  
 324 pages. (Price : \$2.50.)

**1906** **669 .1**  
**WEST (T. Dyson).**  
**Metallurgy of cast iron :** a complete exposition of the  
 processes involved in its treatment, chemically and physic-  
 ally, from the blast furnace through the foundry to the  
 testing machine.

Cleveland, O. Cleveland Printing & Publishing Co. Tenth  
 edition, 12mo, cloth, 20 + 627 pages, illustrations, diagrams.  
 (Price : \$3.)

**In Italian.**

**1906** **691. (01)**  
**PESENTI (Ces.), ing.**  
**Il cemento armato ed il cemento semiarmato :** ricerche  
 teoriche e loro pratiche applicazioni.  
 Bergamo, Istituto italiano d'arti grafiche. In-8°, 269 pagine,  
 fig. con tavola. (Prezzo : L. 8.)



## II. — BIBLIOGRAPHY OF PERIODICALS

(November, 1906.)

## In French.

**Annales des chemins de fer et tramways.**

(Paris.)

**1906** **385**Annales des chemins de fer et tramways, 9<sup>e</sup> livraison, p. 17.

Étude sur le monopole de fait des compagnies de chemins de fer et sur les limites légales de leur activité industrielle et commerciale. (10,000 mots.)

**Bulletin du Congrès international des chemins de fer.** (Bruxelles.)**1906** **625 .144.4**

Bull. du Congrès des chemins de fer, n° 11, novembre, p. 1285.

SCHLÜSSEL (L.). — Note sur le desserrage des assemblages à vis dans les voies de chemins de fer. (6,800 mots &amp; fig.)

**1906** **625 .143.3**

Bull. du Congrès des chemins de fer, n° 11, novembre, p. 1305.

LUBIMOFF (Léon DE). — Note sur l'usure des rails. (4,000 mots, 5 tableaux &amp; fig.)

**1906** **656 .259**

Bull. du Congrès des chemins de fer, n° 11, novembre, p. 1320.

LUX (Friedrich). — L'indicateur des fréquences et des vitesses Frahm. (5,200 mots &amp; fig.)

**1906** **656 .237**

Bull. du Congrès des chemins de fer, n° 11, novembre, p. 1333.

Comptabilité (question XIV, 7<sup>e</sup> session). Discussion. (13,900 mots.)**1906** **656 .237**

Bull. du Congrès des chemins de fer, n° 11, novembre, p. 1362.

RICHTER (J. DE). — Comptabilité (question XIV, 7<sup>e</sup> session). — Lettre au sujet des conclusions de l'exposé n° 2. — Annexe à la discussion. (1,600 mots.)**1906** **385 .581**

Bull. du Congrès des chemins de fer, n° 11, novembre, p. 1367.

Durée et réglementation du travail (question XV, 7<sup>e</sup> session). Discussion. (7,200 mots.)**1906** **385 .57**

Bull. du Congrès des chemins de fer, n° 11, novembre, p. 1384.

ARTHURTON (Alfred W.). — L'instruction professionnelle du personnel des chemins de fer : la « Lecture and Debating Society » du « Great Western Railway ». (3,250 mots.)

**1906** **625 .143.4**

Bull. du Congrès des chemins de fer, n° 11, novembre, p. 1389.

Le joint à double traverse en fer et le cheminement des rails. (3,250 mots, 1 tableau &amp; fig.)

**1906** **625 .143.5**

Bull. du Congrès des chemins de fer, n° 11, novembre, p. 1395.

Essais du tirefond Lakhovsky. (3,300 mots &amp; fig.)

**1906** **625 .251**

Bull. du Congrès des chemins de fer, n° 11, novembre, p. 1405.

L'utilité de proportionner les pressions des sabots de frein aux charges par roue. (1,450 mots.)

**1906** **656 .231**

Bull. du Congrès des chemins de fer, n° 11, novembre, p. 1407.

L'accident de chemin de fer à Salisbury. (1,400 mots.)

**1906** **656 .261**

Bull. du Congrès des chemins de fer, n° 11, novembre, p. 1409.

Les compagnies d'express américaines. (1,500 mots.)

**1906** **016 .385. (02**

Bull. du Congrès des chemins de fer, n° 11, novembre, p. 107.

Bibliographie mensuelle des chemins de fer. — Livres. (17 fiches.)

**1906** **016 .385. (05**

Bull. du Congrès des chemins de fer, n° 11, novembre, p. 109.

Bibliographie mensuelle des chemins de fer. — Périodiques. (166 fiches.)

**Bulletin de l'Institut international de bibliographie.** (Bruxelles.)**1906** **02 (.73)**

Bulletin de l'Institut internat. de bibliographie, fasc. 1-3, p. 5.

LA FONTAINE (H.). — Les bibliothèques américaines. (5,500 mots.)

**Bulletin de la Société d'encouragement pour l'industrie nationale.** (Paris.)**1906** **656 .212.6**

Bull. de la Soc. d'encourag. pour l'ind. nat., n° 8, août-septembre-octobre, p. 869.

Embarquement des charbons aux docks de Penarth et de Newport. (2,400 mots &amp; fig.)



**1906** **669**  
 Bull. de la Soc. d'encour. pour l'ind. nat., n° 3, octobre, p. 253.  
 Contributions françaises aux progrès de la métallurgie  
 scientifique. Rapport de M. F. Osmond. (6,500 mots.)

**1906** **669**  
 Bull. de la Soc. d'encour. pour l'ind. nat., n° 3, octobre, p. 268.  
 La situation de la grosse métallurgie en France.  
 Rapport de MM. Saladin et Charpy. (15,500 mots & 4 ta-  
 bleaux.)

**1906** **669. (01)**  
 Bull. de la Soc. d'encour. pour l'ind. nat., n° 3, octobre, p. 315.  
 CHESNEAU (G.). — Principes théoriques de la précipi-  
 tation chimique envisagée comme méthode d'analyse  
 minérale. (7,200 mots.)

**1906** **669 .1**  
 Bull. de la Soc. d'encour. pour l'ind. nat., n° 3, octobre, p. 332.  
 GUILLET. — Aciers nickel-chrome. (4,600 mots, 3 ta-  
 bleaux & fig.)

**1906** **669 .1**  
 Bull. de la Soc. d'encour. pour l'ind. nat., n° 3, octobre, p. 384.  
 ROGERS (F.). — Sur quelques effets microscopiques  
 produits sur les métaux par l'action des efforts. (3,700  
 mots, 1 tableau & fig.)

**1906** **669 .1**  
 Bull. de la Soc. d'encour. pour l'ind. nat., n° 3, octobre, p. 394.  
 LEJEUNE (P.). — Étude sur la trempe de l'acier.  
 (1,400 mots & fig.)

**Bulletin de la Société des Ingénieurs civils  
 de France. (Paris.)**

**1906** **621 .13 (06.4) (.493)**  
 Bulletin de la Soc. des ing. civ. de France, septembre, p. 310.  
 HERDNER (A.). — Les locomotives à l'exposition de  
 Liège, 1905. (44,000 mots, tableaux & fig.)

**1906** **621 .13' (06.4) (.493)**  
 Bulletin de la Soc. des ing. civ. de France, septembre, p. 490.  
 MALLET (A.). — Observations au sujet du mémoire  
 de M. Herdner sur les locomotives à l'exposition de  
 Liège. (2,000 mots.)

**Génie civil. (Paris.)**

**1906** **625 .3**  
 Génie civil, n° 1274, 10 novembre, p. 17.  
 DUMAS (A.). — Tramway de Clermont-Ferrand au  
 Puy de Dôme à vapeur et à mécanismes d'adhérence  
 supplémentaire. (3,800 mots & fig.)

**Journal des transports. (Paris)**

**1906** **625 .13**  
 Journal des transports, n° 46, 17 novembre, p. 541.  
 HAGUET (H.). — Le tunnel sous la Manche. (1,800  
 mots & fig.)

**Portefeuille économique des machines. (Paris.)**

**1906** **625 .242**  
 Portefeuille économique des machines, n° 611, novembre, p. 161.  
 Wagon-trémie de 20 tonnes, à déchargement automa-  
 tique, système P. Malissard-Taza. (1,000 mots & fig.)

**1906** **625 .251**  
 Portefeuille économique des machines, n° 611, novembre, p. 167.  
 Appareil pour l'étude des freins continus, système  
 Kapteyn, (2,700 mots & fig.) (V. *Bulletin du Congrès des  
 ch. de fer*, n° 8, août, 1906.)

**Revue économique internationale. (Bruxelles.)**

**1906** **625 .61 (01)**  
 Revue économique internationale, n° 1, octobre, p. 225.  
 BELLET (D.). — Chronique des transports. (6,300  
 mots.)

**1906** **385 .14 (.73)**  
 Revue économique internationale, n° 2, novembre, p. 349.  
 VIALATE (A.). — La question des chemins de fer  
 aux États-Unis. (10,500 mots.)

**Revue générale des chemins de fer  
 et des tramways. (Paris.)**

**1906** **621 .131.2**  
 Revue générale des chemins de fer, n° 5, novembre, p. 287.  
 DU BOUSQUET. — Essai de pièces en acier moulé  
 par la compagnie du chemin de fer du Nord. (650 mots  
 & fig.)

**1906** **621 .134.3**  
 Revue générale des chemins de fer, n° 5, novembre, p. 290.  
 SAUVAGE. — La distribution Walschaerts aux États-  
 Unis. (1,300 mots.)

**1906** **625 .234**  
 Revue générale des chemins de fer, n° 5, novembre, p. 293.  
 DUPRIEZ. — Le chauffage des trains sur les lignes  
 exploitées par la compagnie du chemin de fer, à voie de  
 1 mètre de Hermes à Beaumont. (4,200 mots, 4 tableaux  
 & fig.)



**1906** **313 .385 (.42)**  
Revue générale des chemins de fer, n° 5, novembre, p. 306.

Résumé du rapport du « Board of Trade » sur la longueur, la situation financière et les résultats généraux de l'exploitation des chemins de fer du Royaume-Uni, pour l'année 1904. (12 tableaux.)

**1906** **313 .385 (.92) & 313 : 625 .61 (.92)**  
Revue générale des chemins de fer, n° 5, novembre, p. 315.

Progrès des chemins de fer et des tramways à vapeur dans les îles de Java et de Sumatra depuis 1874 jusqu'à 1904. (1 tableau.)

**1906** **313 .385 (.92)**  
Revue générale des chemins de fer, n° 5, novembre, p. 316.

Statistique des résultats obtenus en 1904 sur le réseau des chemins de fer de Sumatra. (5 tableaux.)

**1906** **313 .385 (.92)**  
Revue générale des chemins de fer, n° 5, novembre, p. 319.

Statistique des résultats obtenus en 1904 sur le réseau des chemins de fer de Java. (5 tableaux.)

**1906** **625 .13**  
Revue générale des chemins de fer, n° 5, novembre, p. 322.

Le tunnel sous la Manche. (6,000 mots.)

**1906** **656 .256**  
Revue générale des chemins de fer, n° 5, novembre, p. 331.

Signaux automatiques de block-system pour chemins de fer et tramways à voie normalement ouverte et à courant intermittent, avec contrôleurs de passage à l'arrêt, système Bérard, Dardeau et Détréyat. (2,200 mots & fig.)

**1906** **625 .13**  
Revue générale des chemins de fer, n° 5, novembre, p. 337.

Les sources du tunnel du Simplon. (700 mots & fig.)

#### Revue politique et parlementaire. (Paris.)

**1906** **385 .21**  
Revue politique et parlementaire, n° 149, novembre, p. 357.

COLSON (C.). — Revue des questions de transports. — La navigation intérieure en 1905. (6,000 mots.)

#### In German.

#### Annalen für Gewerbe und Bauwesen. (Berlin.)

**1906** **621 .131.3**  
Annalen für Gewerbe und Bauw., N° 705, 1. November, p. 161.

PFLUG-CHARLOTTENBURG. — Ergebnisse der Lokomotivprüfungen auf dem Versuchsstand der Pennsylvania-Bahn, Welt-Ausstellung St. Louis 1904. (2,500 Wörter, Tabellen & Fig.)

**1906** **621 .132.8**  
Annalen für Gewerbe und Bauw., N° 705, 1. November, p. 169.

GUILLERY. — Neuere über Triebwagen für Eisenbahnen. (4,200 Wörter.)

**1906** **621 .13 (06.4) (.433)**  
Annalen für Gewerbe und Bauw., N° 705, 1. November, p. 173.

HERING (K.). — Das Verkehrs- und Maschinenwesen auf der bayerischen Jubiläums-Landesausstellung zu Nürnberg 1906. (2,000 Wörter & Fig.)

**1906** **388 (.73)**  
Annalen für Gewerbe und Bauw., N° 706, 15. November, p. 184.

BLUM. — Der Verkehr von Gross-New York. (3,200 Wörter & Fig.)

#### Archiv für Eisenbahnwesen. (Berlin.)

**1906** **385. (01) (.68)**  
Archiv für Eisenbahnw., Heft 6, November-Dezember, p. 1149.

KUPKA (P. F.). — Die Eisenbahnen Südafrikas. (4,000 Wörter & Fig.)

**1906** **656 .222.1 (.73)**  
Archiv für Eisenbahnw., Heft 6, November-Dezember, p. 1206.

SCHULZE (W. A.). — Die Fahrgeschwindigkeit der amerikanischen Eisenbahnen. (2,500 Wörter & Tabellen.)

**1906** **313 .385 (.494)**  
Archiv für Eisenbahnw., Heft 6, November-Dezember, p. 1221.

Die Eisenbahnen der Schweiz im Jahre 1904. (Tabellen.)

**1906** **313 .385 (.494)**  
Archiv für Eisenbahnw., Heft 6, November-Dezember, p. 1231.

Die Gotthardbahn im Jahre 1905. (Tabellen.)

**1906** **313 .385 (.493)**  
Archiv für Eisenbahnw., Heft 6, November-Dezember, p. 1237.

Die belgischen Eisenbahnen in den Jahren 1903 und 1904. (Tabellen.)

**1906** **313 .385 (.73)**  
Archiv für Eisenbahnw., Heft 6, November-Dezember, p. 1252.

Die Eisenbahnen der Vereinigten Staaten von Amerika in den Jahren 1902/1903 und 1903/1904. (1,300 Wörter, Tabellen & Fig.)

**1906** **385. (09.3) (.72)**  
Archiv für Eisenbahnw., Heft 6, November-Dezember, p. 1284.

Die Eisenbahnen der Insel Cuba. (1,800 Wörter & Fig.)

**1906** **313 .385 (.47)**  
Archiv für Eisenbahnw., Heft 6, November-Dezember, p. 1299.

Statistisches von den Eisenbahnen Russlands. (Tabellen.)



**Beton und Eisen. (Berlin.)**

**1906** **624 .2**  
Beton und Eisen, Heft X, p. 244.  
— — XI, p. 281.

ZIPKES (S.). — Fachwerkträger aus Eisenbeton.  
(4,000 Wörter, 2 Tabellen & Fig.)

**1906** **624. (01)**  
Beton und Eisen, Heft XI, p. 269.

FORESTIER (V.). — Les ponts de chemins de fer en ciment armé. (2,000 mots & fig.)

**Österreichische Eisenbahn-Zeitung. (Wien.)**

**1906** **385 .517 (.433)**  
Österreichische Eisenbahn-Zeitung, Nr 30, 29. Oktober, p. 281.

FELDSCHÄREK (F.). — Die Wohlfahrtseinrichtungen der kgl. bayerischen Staatseisenbahnen. (1,400 Wörter.)

**1906** **385 .15 (.436)**  
Österreichische Eisenbahn-Zeitung, Nr 33, 19. Novemb., p. 309.

STRACH (H.). — Die Verstaatlichung der Kaiser Ferdinands-Nordbahn. (2,600 Wörter.)

**Elektrische Bahnen und Betriebe.  
Zeitschrift für Verkehrs- und Transportwesen.  
München.)**

**1906** **621 .33**  
Elektrische Bahnen u. Betriebe, Heft 31, 3. November, p. 589.  
— — — 32, 14. — p. 609.

WYSSLING (W.). — Mitteilungen der schweizerischen Studienkommission für elektrischen Bahnbetrieb. (7,000 Wörter, 7 Tabellen & Fig.)

**1906** **656 .212.6**  
Elektrische Bahnen u. Betriebe, Heft 31, 3. November, p. 592.

KOLBEN (E.). — Transporteinrichtungen in Hutten- und Walzwerken. (1,800 Wörter & Fig.)

**1906** **621 .33 (.436)**  
Elektrische Bahnen u. Betriebe, Heft 33, 24. November, p. 629.

ROSA (K.). — Der elektrische Betrieb der Wiener Stadtbahn. (1,900 Wörter & Fig.)

**Organ für die Fortschritte des Eisenbahn-  
wesens in technischer Beziehung. (Wiesbaden.)**

**1906** **625 .231**  
Organ für die Fortschritte des Eisenbahnw., 10. Heft, p. 189.

COURTIN. — Zellen-Wagen für Beförderung von Gefangenen. (1,000 Wörter & Fig.)

**1906** **625 .172**  
Organ für die Fortschritte des Eisenbahnw., 10. Heft, p. 193.

Reitler's Stossstufen-Messer für Schienenstösse. (500 Wörter & Fig.)

**1906** **625 .143.5**  
Organ für die Fortschritte des Eisenbahnw., 10. Heft, p. 194.

ODER (M.). — Die Dorpmüller'sche Gleisklemme gegen das Wandern der Schienen. (1,600 Wörter & Fig.)

**1906** **621 .134.2**  
Organ für die Fortschritte des Eisenbahnw., 10. Heft, p. 196.

METZELTIN. — Neuere Lokomotivsteuerungen. (4,000 Wörter, 2 Tabellen & Fig.)

**1906** **625 .231**  
Organ für die Fortschritte des Eisenbahnw., 10. Heft, p. 204.

Stählerne Personenwagen der New York Zentral-Bahn. (500 Wörter.)

**1906** **656 .256.3**  
Organ für die Fortschritte des Eisenbahnw., 10. Heft, p. 205.

Elektrische Signalanlage der New York Zentral und Hudson-Fluss Bahn in Neu-York. (1,200 Wörter.)

**1906** **656 .256**  
Organ für die Fortschritte des Eisenbahnw., 11. Heft, p. 209.

EDLER (R.). — Ueber einige Anordnungen der Blockwerke und Stellwerksteile zum Ersatze der Hebel- und Unterweg-Sperre bei den Stellhebeln der Ausfahr-signale in Stationen. (2,400 Wörter & Fig.)

**1906** **625 .14 (01)**  
Organ für die Fortschritte des Eisenbahnw., 11. Heft, p. 216.

FRANCKE (A.). — Der Balken mit elastisch gebundenen Auflagern bei Unsymmetrie mit Bezugnahme auf die Verhältnisse des Eisenbahnoberbaues. (1,300 Wörter & Fig.)

**1906** **621 .131.1**  
Organ für die Fortschritte des Eisenbahnw., 11. Heft, p. 219.

WEHRENFENNIG (E.). — Sandstreu-Vorrichtung Bauart Haas. (550 Wörter.)

**1906** **625 .143. (01)**  
Organ für die Fortschritte des Eisenbahnw., 11. Heft, p. 223.

BLUM (O.). — Die Verwendung von alten Schienen auf den Eisenbahnen Indiens und Ceylons. (500 Wörter & Fig.)

**1906** **624 .2 (01 & 721 .9 (01)**  
Organ für die Fortschritte des Eisenbahnw., 11. Heft, p. 224.

BARKHAUSEN (G.). — Theorie der Verbundbauten in Eisenbeton und ihre Anwendung. (4,500 Wörter & Fig.)

**1906** **625 .13**  
Organ für die Fortschritte des Eisenbahnw., 11. Heft, p. 234.

Einspurige und zweispurige Alpentunnel. (300 Wörter & Fig.)

**1906** **625 .142.2**  
Organ für die Fortschritte des Eisenbahnw., 11. Heft, p. 234.

Ueber Holzträngung (1,500 Wörter & 1 Tabelle.)



**1906** **625 .143.4**  
 ran für die Fortschritte des Eisenbahnw., 11. Heft, p. 236.  
 Schleef's Beseitigung der Stossfuge im Eisenbahn-  
 weise. (350 Wörter & Fig.)

**1906** **625 .233**  
 ran für die Fortschritte des Eisenbahnw., 11. Heft, p. 237.  
 Elroy-Zugbeleuchtung. (500 Wörter & Fig.)

**Schweizerische Bauzeitung. (Zürich.)**

**1906** **621 .33**  
 hweizerische Bauzeitung, Nr 16, 20. Oktober, p. 189.  
 — — — Nr 17, 27. — p. 201.

WYSSLING (W.). — Mitteilungen der schweize-  
 schen Studienkommission für elektrischen Bahnbe-  
 ieh. (5,000 Wörter & 7 Tabellen.)

**1906** **621 .33**  
 hweizerische Bauzeitung, Nr 19, 10. November, p. 227.

KUMMER (W.). — Ueber die Anfahrsbeschleunigung  
 ei elektrischen Bahnen. (2,200 Wörter, 1 Tabelle  
 Fig.)

**Zeitschrift des österreichischen Ingenieur- und  
 Architekten-Vereines. (Wien.)**

**1906** **625 .113**  
 eit. des öst. Ingen.- und Archit.-Ver., Nr 45, 9. Novemb., p. 617.

WESSELY (A.). — Zur Theorie des Uebergangs-  
 gens. (2,600 Wörter, 3 Tabellen & Fig.)

**Zeitschrift für Kleinbahnen. (Bern.)**

**1906** **313 : 625 .61 (.493)**  
 Zeitschrift für Kleinbahnen, Heft 11, November, p. 712.

Die Kleinbahnen in Belgien im Jahre 1905. (Tabellen.)

**Zeitschrift des Vereines deutscher Ingenieure.  
 (Berlin.)**

**1906** **656 .212.6**  
 Zeit. des Vereines deutsch. Ingen., Nr 42, 20. Oktober, p. 1697.

BÖTTCHER (A.). — Hammerwippkran für 150 t  
 grösste Last. (1,200 Wörter & Fig.)

**1906** **621 .33 & 625 .4**  
 Zeit. des Vereines deutscher Ingen., Nr 43, 27. Oktober, p. 1736.

MÜLLER (W. A.). — Die Wechselstrom-Hochbahn  
 auf der Internationalen Ausstellung in Mailand 1906.  
 (1,000 Wörter & Fig.)

**1906** **625 .5**  
 Zeit. des Vereines deutsch. Ingen., Nr 44, 3. Novemb., p. 1769.  
 — — — Nr 46, 17. — p. 1867.

DIETERICH (G.). — Die Erschliessung der nordargen-  
 tinischen Kordilleren mittels einer Bleichertschen Draht-  
 seilbahn für Güter und Personen. (6,000 Wörter,  
 1 Tabelle & Fig.)

**Zeitung des Vereines deutscher Eisenbahn-  
 verwaltungen. (Berlin)**

**1906** **385. (09.1 (.73)**  
 Zeitung des Vereins, Nr 80, 17. Oktober, p. 1247.  
 — — — Nr 81, 20. — p. 1263.

GIESE (E.). — Einige Bemerkungen über die Bahn-  
 lage in Nordamerika. (3,600 Wörter & Fig.)

**1906** **385 .15 (.436)**  
 Zeitung des Vereins, Nr 80, 17. Oktober, p. 1251.  
 — — — Nr 81, 20. — p. 1265.

Die Verstaatlichung der Kaiser Ferdinands-Nord-  
 bahn. (5,600 Wörter.)

**1906** **625 .13**  
 Zeitung des Vereins, Nr 82, 24. Oktober, p. 1279.  
 — — — Nr 84, 31. — p. 1314.

BERDROW (W.). — Der Simplontunnel. (6,000  
 Wörter.)

**1906** **656 .222.1 (.434)**  
 Zeitung des Vereins, Nr 82, 24. Oktober, p. 1283.

KUNTZEMÜLLER (A.). — Die Fahrgeschwindigkeit  
 auf den badischen Eisenbahnen. (1,200 Wörter & 1 Ta-  
 belle.)

**1906** **625 .24 (01)**  
 Zeitung des Vereins, Nr 83, 27. Oktober, p. 1295.

MÜLLER. — Güterwagen mit erhöhter Ladefähigkeit  
 und mit Einrichtung zur Selbstentladung. (1,000 Wörter.)

**1906** **656 .211.7**  
 Zeitung des Vereins, Nr 84, 31. Oktober, p. 1311.

BALTZER (F.). — Der Eisenbahnfährdienst zwischen  
 Stralsund und Rügen und das neue Fährschiff „Bergen“. (2,000 Wörter.)

**1906** **656 .234 (.45)**  
 Zeitung des Vereins, Nr 85, 3. November, p. 1327.

Eine Reform der italienischen Personentarife. (800  
 Wörter & 1 Tabelle.)

**1906** **656 .2 (01)**  
 Zeitung des Vereins, Nr 86, 7. November, p. 1343.

SIGEL. — Der Entwurf einer neuen deutschen Ver-  
 kehrsordnung. (4,800 Wörter.)



**1906** **625 .175**  
 leitung des Vereins, Nr 87, 10. November, p. 1359.  
 KOLL (F.). — Benzinmotor-Draisinen. (1,000 Wörter.)

**1906** **385 .113 (.433)**  
 leitung des Vereins, Nr 87, 10. November, p. 1362.

Betriebsergebnisse der bayerischen Staatseisenbahnen im Jahre 1905. (2,400 Wörter.)

**1906** **385. (09.1 (.7))**  
 leitung des Vereins, Nr 88, 14. November, p. 1375.

ERBSTEIN (A.). — Die panamerikanische Eisenbahn. 3,600 Wörter & 3 Tabellen.)

**1906** **656 .222.1**  
 leitung des Vereins, Nr 88, 14. November, p. 1379.

SCHULZE (W. A.). — Fahrgeschwindigkeitsrekord auf deutschen Eisenbahnstrecken. (800 Wörter.)

**1906** **656 .235**  
 leitung des Vereins, Nr 89, 17. November, p. 1391.

PITSCH. — Annahme der Güter auf grossen Stationen. (1,900 Wörter.)

**1906** **625 .142.2**  
 leitung des Vereins, Nr 89, 17. November, p. 1394.

LIEBENSTEIN (Frhr. v.). — Neuere Holztränkungsverfahren. (1,700 Wörter.)

**1906** **625 .236**  
 leitung des Vereins, Nr 90, 21. November, p. 1407.

GUILLERY (C.). — Staubsauganlage mit Betrieb durch Druckluft. (1,800 Wörter.)

**1906** **656 .254**  
 leitung des Vereins, Nr 91, 24. November, p. 1423.

MARTENS (H. A.). — Nachrichtengebung vom ahrenden Zuge. (1,000 Wörter.)

**Zentralblatt der Bauverwaltung. (Berlin.)**

**1906** **656 .211.4 & 725 .31**  
 entralblatt der Bauverwaltung, Nr 91, 10. November, p. 580.

EVERKEN. — Die neuen Bahnhofsanlagen in und ei Wiesbaden. (1,700 Wörter & Fig.)

**In English.**

**American Engineer and Railroad Journal. (New York.)**

**1906** **621 .132.4**  
 merican Engineer & R. Journal, No. 11, November, p. 411.

Cole four-cylinder balanced compound Pacific type ocomotive. (1,500 words & fig.)

**1906** **621 .134.3**  
 American Engineer & R. Journal, No. 11, November, p. 426.

COSTER (E. L.). — The mathematical analysis of the Walschaert valve gear. (1,400 words & fig.)

**American Machinist. (New York.)**

**1906** **51. (08)**  
 American Machinist, No. 44, November 17, p. 555.

KENNEDY (H. J.). — An ingenious calculating machine. (5,000 words, tables & fig.)

**1906** **727 .4**  
 American Machinist, No. 45, November 24, p. 593.

The new engineering building of the university of Pennsylvania. (2,400 words & fig.)

**Bulletin of the International Railway Congress. (Brussels.)**

**1906** **625 .251**  
 Bulletin of the Railway Congress, No. 11, November, p. 1647.

FÜHR (A.). — The Kapteyn apparatus for recording continuous brake trials. (2,500 words & fig.)

**1906** **621 .335**  
 Bulletin of the Railway Congress, No. 11, November, p. 1657.

HILD (E. W.). — The gasoline car for interurban service. (6,600 words & fig.)

**1906** **621 .131.3 & 656 .222.1**  
 Bulletin of the Railway Congress, No. 11, November, p. 1672.

Recent high-speed trials of steam locomotives. (2,900 words & 2 tables.)

**1906** **385. (09.1 (.54))**  
 Bulletin of the Railway Congress, No. 11, November, p. 1679.

BLUM & GIESE (E.). — The passenger service on the Ceylon railways. (2,100 words, 2 tables & fig.)

**1906** **656 .23**  
 Bulletin of the Railway Congress, No. 11, November, p. 1685.

Suburban traffic (question XII, 7<sup>th</sup> session). Discussion. (11,700 words.)

**1906** **656 .235**  
 Bulletin of the Railway Congress, No. 11, November, p. 1711.

Slow freight rates (question XIII, 7<sup>th</sup> session). Discussion. (14,000 words.)

**1906** **656 .235 (.54)**  
 Bulletin of the Railway Congress, No. 11, November, p. 1741.

DRING (William A.). — Slow freight rates (question XIII, 7<sup>th</sup> session). — Note on the freight rates on the Indian railways. — Appendix to the discussion. (3,500 words.)



**906** **54**  
 letin of the Railway Congress, No. 11, November, p. 1748.  
 'he radium controversy. (2,350 words.)

**906** **625 .143.2**  
 letin of the Railway Congress, No. 11, November, p. 1751.  
 'hosphorus in steel rails. (1,700 words.)

**906** **625 .251**  
 letin of the Railway Congress, No. 11, November, p. 1754.  
 'roportioning brake-shoe pressures to wheel loads.  
 00 words.)

**906** **656 .261**  
 letin of the Railway Congress, No. 11, November, p. 1756.  
 'he express companies. (1,400 words.)

**906** **621 .131.2**  
 letin of the Railway Congress, No. 11, November, p. 1758.  
 imits for weight on axles. (1,150 words.)

**906** **016 .385. (02**  
 letin of the Railway Congress, No. 11, November, p. 107.  
 Monthly bibliography of railways. — Books. (17 labels.)

**906** **016 .385. (05**  
 letin of the Railway Congress, No. 11, November, p. 109.  
 Monthly bibliography of railways. — Periodicals.  
 5 labels.)

**Engineer. (London.)**

**906** **624 .8**  
 ineer, No. 2651, October 19, p. 390.  
 New swing bridge at Velsen. (1,200 words & fig.)

**906** **725 .32**  
 ineer, No. 2652, October 26, p. 411.  
 'he new goods station at Newcastle. (3,800 words  
 g.)

**906** **625 .13 & 625 .4**  
 ineer, No. 2652, October 26, p. 414.  
 — No. 2653, November 2, p. 439.  
 IALDEN (G. M.). — Setting out of tube railways.  
 300 words, 1 table & fig.)

**906** **621 .132.8**  
 ineer, No. 2652, October 26, p. 432.  
 — No. 2653, November 2, p. 456.  
 ICHES (T. H.) & HASLAM (S. B.). — Railway motor  
 traffic. (4,500 words, 3 tables & fig.)

**906** **624 .63**  
 ineer, No. 2653, November 2, p. 442.  
 Erection of a concrete bridge. (1,100 words & fig.)

**1906** **621 .132.3**  
 Engineer, No. 2653, November 2, p. 446.  
 Prairie type locomotive—Northern Pacific Railroad.  
 (400 words & fig.)

**1906** **625 .13**  
 Engineer, No. 2654, November 9, p. 465.  
 The Channel tunnel project. (2,200 words & fig.)

**1906** **625 .251**  
 Engineer, No. 2654, November 9, p. 484.  
 The Maximus brake. (700 words & fig.)

**1906** **621 .13 (.42)**  
 Engineer, No. 2655, November 16, p. 500.  
 — No. 2656, — 23, p. 518.  
 Locomotive development on British railways. (4,100  
 words & tables.)

**1906** **621 .132.4**  
 Engineer, No. 2655, November 16, p. 508.  
 Six-coupled bogie goods engine. (450 words & fig.)

**1906** **621 .14**  
 Engineer, No. 2656, November 23, p. 534.  
 CLARKSON (T.). — Steam as a motive power for  
 public service vehicles. (3,000 words & fig.)

**Engineering. (London.)**

**1906** **656 .257**  
 Engineering, No. 2130, October 26, p. 554.  
 — No. 2131, November 2, p. 588.  
 Electrically operated points and signals at Didcot.  
 (3,000 words & fig.)

**1906** **621 .132.5**  
 Engineering, No. 2130, October 26, p. 556.  
 Four-cylinder compound ten-coupled locomotive;  
 Milan exhibition. (1,000 words & fig.)

**1906** **621 .336**  
 Engineering, No. 2130, October 26, p. 573.  
 JENKIN (C. F.). — The advent of single-phase electric  
 traction. (7,700 words.)

**1906** **621 .132.8**  
 Engineering, No. 2131, November 2, p. 591.  
 Steam rail motor-car for the Lancashire & Yorkshire  
 Railway. (500 words & fig.)

**1906** **625 .616**  
 Engineering, No. 2132, November 9, p. 632.  
 Narrow-gauge locomotive at the Milan exhibition.  
 (450 words & fig.)



- 1906** **621 .132.3**  
Engineering, No. 2133, November 16, p. 673.  
Four-cylinder compound six-coupled locomotive for the Austrian State Railways. (350 words & fig.)
- 1906** **621 .33**  
Engineering, No. 2134, November 23, p. 683.  
The electrification of the Simplon tunnel. (4,500 words & fig.)
- 1906** **621 .14**  
Engineering, No. 2134, November 23, p. 709.  
CLARKSON (T.). — Steam as a motive power for public-service vehicles. (5,500 words & fig.)

**Engineering Magazine. (London.)**

- 1906** **385. (07.13)**  
Engineering Magazine, November, p. 169.  
BECKER (O. M.). — A modern adaptation of the apprentice-ship system. (3,000 words.)
- 1906** **621 .7**  
Engineering Magazine, November, p. 177.  
JACOBS (H. W.). — Organization and economy in the railway machine shop. (3,200 words & fig.)

**Engineering News. (New York.)**

- 1906** **621 .33 (.73)**  
Engineering News, No. 19, November 8, p. 467.  
Conversion of the Atlantic City Line of the West Jersey & Seashore R. R. Co. (Pennsylvania R. R. System) to electric traction. (5,500 words & fig.)
- 1906** **625 .113**  
Engineering News, No. 20, November 15, p. 502.  
ROSS (T. A.). — A simplified method of laying out transition curves. (600 words, 1 table & fig.)
- 1906** **656 .281**  
Engineering News, No. 20, November 15, p. 514.  
Rails and rail-lifts on the thoroughfare draw near Atlantic City, N. J., Newfield branch of West Jersey & Seashore R. R. (1,500 words & fig.)

**Great Western Railway Magazine. (London.)**

- 1906** **385 .113 (.42)**  
Great Western Railway Magazine, November, p. 218.  
The Board of Trade Railway returns. (550 words & tables.)

**Indian Engineering. (Calcutta.)**

- 1906** **624 .32**  
Indian Engineering, No. 18, November 3, p. 286.  
STONE (E. W.). — The new Chittravate bridge, Madras Railway. (2,300 words & fig.)

**Journal of the Franklin Institute. (Philadelphia.)**

- 1906** **621 .133.7**  
Journal of the Franklin Institute, No. 4, October, p. 279.  
KNEASS (S. L.). — High pressure steam tests of an injector. (2,500 words & fig.)

**Locomotive Firemen's Magazine. (Indianapolis.)**

- 1906** **625 .253**  
Locomotive Firemen's Magazine, November, p. 622.  
Westinghouse compound air pumps. (2,200 words, 1 table & fig.)
- 1906** **621 .133.7**  
Locomotive Firemen's Magazine, November, p. 629.  
The modern locomotive injector. (2,800 words, 4 tables & fig.)

**Locomotive Journal. (Leeds.)**

- 1906** **625 .13**  
Locomotive Journal, No. 11, November, p. 533.  
The construction of a new bridge under an existing railway. (2,700 words & fig.)

**Locomotive Magazine. (London.)**

- 1906** **621 .132.8**  
Locomotive Magazine, No. 171, November 15, p. 184.  
Steam rail motor coaches. (700 words & fig.)

**Page's Weekly. (London.)**

- 1906** **621 .14**  
Page's Weekly, No. 115, November 23, p. 1139.  
CLARKSON (T.). — Steam as a motive power for public service vehicles. (2,400 words & fig.)

**Proceedings of the Institution of Civil Engineers. (London.)**

- 1905-06** **656 .211.7**  
Proceedings of the Inst. of Civil Eng., vol. CLXV, p. III, p. 87.  
WEBSTER (J. J.). — The Widnes and Runcorn transporter-bridge. (22,000 words, tables & fig.)



**1905-06** **624 .1**  
 Proceedings of the Inst. of Civil Eng., vol. CLXV, p<sup>t</sup> III, p. 219.

ESLING (F. K.). — A problem relating to railway-bridge piers of masonry of brickwork. (2,700 words, 3 tables & fig.)

**1905-06** **624 .2**  
 Proceedings of the Inst. of Civil Eng., vol. CLXV, p<sup>t</sup> III, p. 231.

BOYCOTT (G. W. M.). — Caisson-disease at the New High-Level bridge, Newcastle-on-Tyne. (2,000 words, 1 table & fig.)

**Railroad Gazette. (New York.)**

**1906** **621 .132.8 (.42)**  
 Railroad Gazette, No. 15, October 12, p. 310.

Rail-motor-car traffic in England. (2,600 words, 1 table & fig.)

**1906** **621 .132.5**  
 Railroad Gazette, No. 15, October 12, p. 315.

Mallet compound locomotive for the Great Northern. (1,700 words & fig.)

**1906** **621 .133.1**  
 Railroad Gazette, No. 16, October 19, p. 335.

BEMENT (A.). — Testing coal. (3,300 words.)

**1906** **625 .235**  
 Railroad Gazette, No. 16, October 19, p. 342.

Steel passenger cars built by the Pressed Steel Car Company. (700 words & fig.)

**1906** **621 .132 (.73)**  
 Railroad Gazette, No. 16, October 19, p. 344.

FOWLER (G. L.). — The development of American freight locomotives. (2,200 words & fig.)

**1906** **656 .212.6**  
 Railroad Gazette, No. 17, October 26, p. 356.

Hullett car dumping machine. (800 words & fig.)

**1906** **656 .253**  
 Railroad Gazette, No. 17, October 26, p. 368.

A comprehensive signaling scheme. (500 words & fig.)

**1906** **625 .13**  
 Railroad Gazette, No. 18, November 2, p. 380.

The Pennsylvania tunnels Across Manhattan Island. (1,500 words & fig.)

**1906** **621 .132.5**  
 Railroad Gazette, No. 18, November 2, p. 389.

Mallet compounds for the Erie. (250 words & fig.)

**1906** **625 .245**  
 Railroad Gazette, No. 18, November 2, p. 390.

Track inspection car on the Baltimore & Ohio. (1,200 words & fig.)

**1906** **625 .236**  
 Railroad Gazette, No. 18, November 2, p. 392.

FLORY (B. F.). — Car cleaning. (1,600 words & fig.)

**1906** **656 .222.1 (.73)**  
 Railroad Gazette, No. 18, November 2, p. 394.

Records of fast runs. (500 words & 1 table.)

**1906** **621 .132.3**  
 Railroad Gazette, No. 19, November 9, p. 406.

Heavy Pacific type locomotive for the Northern Pacific. (1,500 words & fig.)

**1906** **621 .132.4**  
 Railroad Gazette, No. 19, November 9, p. 414.

Balanced compound Prairie type locomotives for the Atchison, Topeka & Santa Fe. (500 words & fig.)

**1906** **621 .33 (.73)**  
 Railroad Gazette, No. 19, November 9, p. 415.

Electrification of the West Jersey & Seashore. (1,800 words & fig.)

**1906** **621 .138.2**  
 Railroad Gazette, No. 20, November 16, p. 435.

Anthracite coal storage. (500 words & fig.)

**1906** **621 .132.8**  
 Railroad Gazette, No. 20, November 16, p. 437.

Union Pacific motor car No. 8. (150 words & fig.)

**Railway Age. (Chicago.)**

**1906** **621 .132.5**  
 Railway Age, No. 1585, October 26, p. 514.

Heavy consolidation locomotive for the Delaware & Hudson. (600 words & fig.)

**1906** **621 .33 (.73)**  
 Railway Age, No. 1587, November 9, p. 572.

Electrical equipment of the West Jersey & Seashore branch of the Pennsylvania Railroad. (3,800 words & fig.)

**1906** **621 .132.3**  
 Railway Age, No. 1587, November 9, p. 582.

Four-cylinder compound Pacific locomotive for the Northern Pacific. (1,200 words & fig.)

**1906** **625 .245**  
 Railway Age, No. 1587, November 9, p. 589.

A car for transportation of live poultry. (200 words & fig.)



**1906** **625 .13**  
*Railway Age*, No. 1588, November 16, p. 609.  
 Railway tunnels to Manhattan Island. (2,500 words & fig.)

**Railway Engineer. (London.)**

**1906** **656 .255**  
*Railway Engineer*, No. 322, November, p. 347.  
 Union Switch & Signal Co's new train staff. (1,200 words & fig.)

**Railway and Engineering Review. (Chicago.)**

**1906** **621 .331**  
*Railway and Engineering Review*, No. 41, October 13, p. 794.  
 Contracting for hydro-electric power on railways. (2,300 words & fig.)

**1906** **621 .132.4**  
*Railway and Engineering Review*, No. 44, November 3, p. 848.  
 Heavy Prairie type locomotive, A. T. & S. F. Ry. (400 words & fig.)

**1906** **621 .7**  
*Railway and Engineering Review*, No. 44, November 3, p. 851.  
 Inspection of materials for railway equipment during process of manufacture and construction, and its advantages. (2,200 words & fig.)

**1906** **625 .154**  
*Railway and Engineering Review*, No. 44, November 3, p. 853.  
 GREENLEAF (C. A.). — Evolution of the railway turntable. (700 words & fig.)

**1906** **625 .151 & 656 .257**  
*Railway and Engineering Review*, No. 46, November 17, p. 890.  
 New signals for facing-point switches on the Harri-man lines. (250 words & fig.)

**1906** **621 .132.3**  
*Railway and Engineering Review*, No. 46, November 17, p. 894.  
 40,000th locomotive built by the American locomotive Co. (800 words & fig.)

**1906** **625 .144. (01**  
*Railway and Engineering Review*, No. 46, November 17, p. 895.  
 Maintaining track for the tonnage and speed of today. (2,400 words & fig.)

**Railway Gazette. (London.)**

**1906** **621 .32 & 625 .233**  
*Railway Gazette*, No. 17, October 26, p. 454.  
 The Vickers-hall system of electric train lighting. 800 words & fig.)

**1906** **621 .132.8**  
*Railway Gazette*, No. 17, October 26, p. 456.  
 Rail motor car, Isle of Wight Central Railway. (500 words & fig.)

**1906** **621 .132.5**  
*Railway Gazette*, No. 17, October 26, p. 463.  
 Mallet compound locomotive for the Great Northern. (1,700 words & fig.)

**1906** **625 .232**  
*Railway Gazette*, No. 18, November 2, p. 485.  
 New corridor trains, Great Eastern Railway. (350 words & fig.)

**1906** **625 .235**  
*Railway Gazette*, No. 18, November 2, p. 490.  
 Steel passenger cars built by the Pressed Steel Car Company. (700 words & fig.)

**1906** **621 .132 (.73)**  
*Railway Gazette*, No. 18, November 2, p. 492.  
 FOWLER (G. L.). — The development of American freight locomotives. (2,200 words & fig.)

**1906** **656 .253**  
*Railway Gazette*, No. 19, November 9, p. 516.  
 A comprehensive signaling scheme. (500 words & fig.)

**1906** **621 .336**  
*Railway Gazette*, No. 20, November 16, p. 530.  
 JENKIN (C. F.). — Single-phase electric traction. (2,600 words & fig.)

**1906** **656 .255**  
*Railway Gazette*, No. 20, November 16, p. 533.  
 Improvements in signalling on single lines. (1,100 words & fig.)

**1906** **625 .236**  
*Railway Gazette*, No. 20, November 16, p. 540.  
 FLORY (B. F.). — Car cleaning. (1,600 words & fig.)

**1906** **656 .222.1 (.73)**  
*Railway Gazette*, No. 20, November 16, p. 542.  
 Records of fast runs. (500 words & 1 table.)

**1906** **621 .132.8**  
*Railway Gazette*, No. 21, November 23, p. 557.  
 Condensing in steam-electric locomotives. (500 words & fig.)

**1906** **621 .33 (.73)**  
*Railway Gazette*, No. 21, November 23, p. 563.  
 Electrification of the West Jersey & Seashore. (1,500 words & fig.)



**Railway and Locomotive Engineering.** (New York.)

**1906** **624 .63**  
 Railway and Locomotive Engineering, November, p. 491.  
 Concrete viaduct. (700 words & fig.)

**Railway Machinery.** (New York.)

**1906** **621 .131.2**  
 Railway Machinery, November, p. 116.  
 FOWLER (G. L.) & MELLIN (C. J.). — The designing of a locomotive. (1,600 words & fig.)

**Railway Magazine.** (London.)

**1906** **385. (09.1) (.42)**  
 Railway Magazine, No. 113, November, p. 393.  
 SEKON (G. A.). — Illustrated interview. (4,800 words, 1 table & fig.)

**1906** **656 .211.5**  
 Railway Magazine, No. 113, November, p. 416.  
 New train departure indicator at Liverpool street terminus. (800 words & fig.)

**1906** **621 .132.1 (.42) & 656 .222.1 (.42)**  
 Railway Magazine, No. 113, November, p. 460.  
 ROUS-MARTEN (C.). — British locomotive practice and performance. (3,500 words & fig.)

**Railway Maintenance and Structures.** (New York.)

**1906** **625 .142.3**  
 Railway Maintenance and Structures, November, p. 227.  
 PORTER (H. T.). — Experience with steel ties on the Bessemer & Lake Erie R. R. (2,100 words.)

**Railway Master Mechanic.** (Chicago.)

**1906** **621 .7**  
 Railway Master Mechanic, No. 11, November, p. 357.  
 Angus shops. Canadian Pacific Railway. (3,200 words & fig.)

**1906** **621 .135.1**  
 Railway Master Mechanic, No. 11, November, p. 377.  
 Welding broken locomotive frames by the thermit process—Central Railroad of New Jersey. (700 words & fig.)

**Railway Times.** (London.)

**1906** **621 .33 & 625 .4**  
 Railway Times, No. 19, November 10, p. 473.  
 The Great Northern Piccadilly and Brompton Railway. (2,500 words & fig.)

**1906** **621 .132.8**  
 Railway Times, No. 21, November 24, p. 521.  
 South Western Railway motor car development. (300 words & fig.)

**South African Railway Magazine.** (Johannesburg.)

**1906** **656 .28 (01)**  
 South African Railway Magazine, No. 3, November, p. 136.  
 MOORE (W.). — Minor railway accidents. (2,100 words & fig.)

**Street Railway Journal.** (New York.)

**1906** **621 .336**  
 Street Railway Journal, No. 18, November 3, p. 870.  
 Experimental three-wire system in Vienna. (2,000 words & fig.)

**1906** **621 .331**  
 Street Railway Journal, No. 18, November 3, p. 875.  
 Sub-stations and transmission system of the New York Central & Hudson River Railroad. (2,200 words & fig.)

**1906** **621 .33**  
 Street Railway Journal, No. 19, November 10, p. 928.  
 The electrical equipment of the West Jersey & Seashore Branch of the Pennsylvania Railroad. (6,600 words, tables & fig.)

**1906** **625 .215**  
 Street Railway Journal, No. 19, November 10, p. 947.  
 FOWLER (G. L.). — Tables of car positions on curves. (250 words & tables.)

**Tramway & Railway World.** (London.)

**1906** **621 .33 (09.1) & 625 .61 (.42)**  
 Tramway & Railway World, November, p. 433.  
 Burton and Ashby light railways. (4,000 words & fig.)

**In Italian.**

**Giornale del genio civile.** (Roma.)

**1906** **621 .33 (.45)**  
 Giornale del genio civile, settembre, p. 505.  
 Ancora delle ferrovie elettriche Valtellinesi. (3,600 parole.)



**1906** **625 .216**  
Giornale del genio civile, settembre, p. 513.

Apparecchio Pavia-Casalis per l'agganciamento automatico dei carri ferroviari. (2,400 parole & fig.)

**1906** **656 .234**  
Giornale del genio civile, settembre, p. 517.

La tariffa differenziale per i viaggiatori. (900 parole & 2 tavole.)

**Ingegneria ferroviaria. (Roma.)**

**1906** **621 .33 & 656 .27**  
Ingegneria ferroviaria, n° 21, 1° novembre, p. 350.

Le automotrici benzoelettriche delle ferrovie ungheresi. (1,500 parole, 2 tavole & fig.)

**1906** **625 .1**  
Ingegneria ferroviaria, n° 22, 16 novembre, p. 357.

FERRARIO (C.). — Pro spluga. (6,300 parole.)

**1906** **621 .132.3 (.45)**  
Ingegneria ferroviaria, n° 22, 16 novembre, p. 366.

Locomotiva compound a 4 cilindri gruppo 6 4 0 delle ferrovie dello Stato. (1,800 parole & fig.)

**1906** **621 .336**  
Ingegneria ferroviaria, n° 22, 16 novembre, p. 369.

La terza rotaia delle ferrovie Varesine. (750 parole, 1 tavole & fig.)

**Rivista generale delle ferrovie e dei lavori pubblici. (Firenze.)**

**1906** **621 .33**  
Rivista generale delle ferrovie, n° 46, 11 novembre, p. 723.

LANINO (P.). — Considerazioni intorno all'applicazione della trazione elettrica alle linee di valico. (3,400 parole.)

**1906** **721 .4 (01**  
Rivista generale delle ferrovie, n° 47, 18 novembre, p. 738.

Esame critico delle formule in uso per il calcolo delle volte. (1,800 parole.)

**In Dutch.**

**Ingenieur. ('s Gravenhage.)**

**1906** **621 .116**  
Ingenieur, n° 46, 17 November, p. 855.

DE KUYSER (J.). — Automatische stookinrichtingen. (4,500 woorden, 1 tafereel & fig.)









This book should be returned to  
the Library on or before the last date  
stamped below.

A fine of five cents a day is incurred  
by retaining it beyond the specified  
time.

Please return promptly.

v.20<sup>3</sup>  
July-Dec.  
1906

International railway  
congress association

... Bulletin ...



